

OVERCOMING BARRIERS TO IMPROVING INFANT AND YOUNG CHILD FEEDING PRACTICES IN THE BOLIVIAN ANDES: THE ROLE OF AGRICULTURE AND RURAL LIVELIHOODS

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The broad goal of this research was to determine the role that agriculture and rural livelihoods play in affecting the infant and young child feeding (IYCF) and care practices of women in a semi-subsistence farming region in the central highlands of Bolivia. Specifically, the study aimed to determine the nature of the relationship between IYCF practices and child nutritional status, the kinds of barriers mothers face to improving IYCF practices and, using an agriculture-centered nutrition education intervention as a catalyst for understanding how to overcome these barriers, determine if and how women were able to improve these practices.

Baseline and endline surveys of 331 and 390 households with infants or young children were conducted in March 2009 and March 2010, respectively. Data on child diets and nutritional status, IYCF practices, and household agricultural practices were collected. From these data, an infant and child feeding index (ICFI) was constructed to measure the quality of maternal IYCF practices. An agriculture-centered nutrition education intervention was implemented between survey rounds focused on improving IYCF practices using agriculture as an entry point for changing women's behaviors, particularly their time allocation to child feeding and the quality of complementary foods fed to young children. In-depth interviews were also conducted to examine barriers women faced to improving IYCF practices.

The composite ICFI was positively associated with child growth and the adequacy of child diets. Feeding frequency and maintenance of breastfeeding were most strongly associated with child growth. Interview data revealed that women face multiple barriers to improving IYCF practices. Chief among these barriers were issues related to the limited diversity of household agricultural production, time spent maintaining subsistence crops and herding animals, and the lack of support received from other family members including spouses and mothers-in-law. Mothers in communities where intervention activities were conducted showed a significant increase in ICFI scores from baseline to endline compared to mothers in control communities.

The study underscores the importance of considering environmental influences, particularly the role of agricultural livelihoods on caregivers' time use, when designing programs aimed at improving IYCF practices.

BIOGRAPHICAL SKETCH

Andrew David Jones was born and raised in Pittsburgh, Pennsylvania. He attended The Pennsylvania State University where he obtained Bachelor of Arts degrees in film production and geography. After returning home from a transformative semester spent abroad in South Africa during his third college semester, Andrew decided to join the United States Peace Corps following graduation. This decision led him to a rural village in eastern Kazakhstan where he spent two years teaching environmental education, English and geography to primary and secondary school students.

When he returned home from his service with the Peace Corps he sought to further his education in a field that would allow him to pursue his burgeoning interest in serving vulnerable communities internationally. He discovered nutrition as a discipline central to improving the health and well-being of such communities and foundational to other development efforts. His graduate studies and the field research for this dissertation allowed Andrew to continue pursuing his passions for service, learning, teaching and filmmaking.

to my parents,

Kevin and Sandra Jones, whose unwavering sacrifices for their children have made every achievement, every adventure, every step forward on life's path possible.

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The other members of my Special Committee: Jere Haas, Rebecca Nelson and Dennis Miller also provided indispensable guidance that heavily informed my path in graduate school. Jere's interdisciplinary expertise in anthropology and the biological sciences and his considerable time spent conducting research in Peru and Bolivia assured that my research was grounded not only in nutritional science, but also the culture and context of the Andes. Rebecca, though a plant pathologist by training, always provided incredibly insightful guidance on a wide range of nutrition issues and pushed me to examine in increasing depths, the linkages between nutrition

outcomes and behaviors and the local agroecology of northern Potosí, Bolivia. Her brilliance as a scholar and drive as a grantmaker to improve the lives of smallholder farmers immensely strengthened my Special Committee and shaped my own growth as a scholar. Dennis never failed to thoughtfully comment on my writing, respond to my correspondences or provide encouragement and suggestions as I pursued my studies.

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1. Introduction: Agriculture and Nutrition in Perspective

1.1 Fickle paradigms

The field of nutrition has progressed in a sequence of paradigm shifts characterized as much by changes in ideology, ethics and political values as by advancements in scientific knowledge (Jonsson, 2010). Notwithstanding important exceptions, these paradigms have often gravitated toward reductionist approaches to improving undernutrition. The discovery of protein in the 19th century and the subsequent chain of discoveries in the first quarter of the 20th century of the fat- and water-soluble vitamins led to an early movement in nutrition toward diet prescriptions based on combinations of individual nutrients rather than on traditionally-accepted standards of dietary adequacy and diversity (Rivers, 1979). As newly-emerging nutrition experts began to professionalize the field, the problem of undernutrition began to be increasingly viewed as a technical issue requiring scientific solutions.

The so-called “protein era” that followed World War II, wherein nutrition research was “totally dominated” (Jonsson, 2010) by efforts to increase global protein intakes, intensified this trend toward nutrient-specific solutions. Though critics eventually denounced this approach as myopic, arguing that a focus on protein alone ignored the underlying social ills of poverty and inequality that drive undernutrition (McLaren, 1974; Harper et al, 1973), similar strategies, focused on the proximal causes of the problem, continued to emerge. UNICEF’s global GOBI strategy, for example, launched in 1982 (*growth monitoring, oral rehydration, breastfeeding, immunization*) and their GOBI-FFF approach initiated the following year (*female education,*

family spacing and food supplements) marked a continued emphasis on technical fixes to undernutrition (Quinn, 1994). These strategies were heavily criticized for again overlooking the structural basis of nutrition problems.

Most recently, the dominant paradigm guiding global efforts to alleviate undernutrition has focused on the provision of micronutrients, vitamins and minerals required by humans in micro- or trace amounts (e.g. iron, folate, iodine, vitamin A and zinc), through the fortification of regional and national food supplies and through the direct supplementation of target populations. These efforts have been critically important to alleviating individual nutrient deficiencies and the often debilitating consequences resulting from them (Bhutta et al, 2008). Supplementation and fortification efforts by design however, similarly neglect to address the multiple underlying determinants of undernutrition. The wisdom of continuing micronutrient supplementation trials has been challenged recently given the failure of many of these trials to demonstrate substantial benefits to target populations (Prentice, 2011).

1.2 Improving nutrition through agriculture: an historical perspective

Improving nutrition through agriculture has never surfaced as a distinct paradigm among the nutrition community though it has been consistently recognized as an integral part of structural solutions that address malnutrition. Agriculture produces much of the world's food, fiber, materials for shelter, and medicinal plants (Hawkes and Ruel, 2006), all of which serve as the primary foundation for sustaining human communities. In particular, for the nearly three-

quarters of the world's poor people who live in rural areas of developing countries, many of whom depend on agriculture for livelihood and food security (Pinstrup-Andersen, 2007), the food derived from agricultural production or purchased through the sale of produced goods is a key determinant of nutrition outcomes (Haddad, 2000). This linkage has long been appreciated. Three-quarters of a century ago experts recognized the importance of agricultural adaptation for meeting human nutritional requirements (League of Nations, 1937; Zimmerman, 1938). They noted that, in addition to agriculture's powerful role in meeting the existing demand of consumers for more diversified diets, changes in production decisions that supported more "protective" foods (i.e. fruits and vegetables) could influence consumption behaviors that could in turn lead to nutritional benefits. Two decades later, architects of the "Green Revolution" responded to impending famines in much of the developing world by developing high-yielding varieties of cereal grains such as wheat and rice dependent upon chemical fertilizers, pesticides and abundant water for irrigation (IFPRI, 2002). These new varieties were shorter than earlier cultivars, had a higher harvest index (of grain to straw), and a reduced growth duration with photoperiod insensitivity to allow for higher yields and increased crop intensity (Davies, 2003). From the mid-1960s to 1990 world rice production doubled and unprecedented growth in wheat production followed close behind.

Though Green Revolution technologies were a boon for many farmers and consumers in low-income countries, observers soon recognized that increased food production was not sufficient to reduce malnutrition or stave off deadly famines. Even in the absence of declines in national food availability, famines persisted in Asia and Africa due in large part to a lack of food

entitlements, or individuals' abilities to acquire or retain food (Sen, 1981). Despite the lofty pronouncement at the 1974 World Food Conference in Rome by then-U.S. Secretary of State Henry Kissinger that in ten years no child would go to bed hungry, hunger statistics actually deteriorated in the latter half of the 1970s (Kissinger, 1974; Swaminathan, 1981).

By the early 1980s, the favored nutrition paradigm of the previous decade, multisectoral nutrition planning, an approach aimed at identifying solutions to undernutrition that were explicitly embedded in overall development planning and that cut across the agriculture, health, and education sectors, was largely seen as a failure (Jonsson, 2010). The ponderous complexity of conceptual and organizational plans, an ignorance of political economy and failure to address the realities of project implementation limited the effectiveness of multisectoral planning schemes (Field, 1987). In parallel with these efforts, the so-called "integrated rural development" projects of the 1970s that were strongly promoted by Robert McNamara, then head of the World Bank, similarly sought to achieve public health advances through multisectoral, multifunctional agricultural and rural development interventions (Lele, 2005). Though boasting some success, these top-down projects largely floundered when faced with implementation difficulties and the realization that improvements to physical infrastructure and agricultural development alone are not sufficient to achieve improved health and nutrition outcomes (Cohen, 1987; Koppel, 1987; Lele, 2005).

However, realization of the importance of expanding responsibility for nutrition issues beyond the health sector and addressing the structural dimensions of undernutrition carried over from

this planning era such that malnutrition began to be increasingly seen as a “development” problem and not just a clinical condition (Berg and Austin, 1984). In this context, calls for the explicit incorporation of nutritional goals into agriculture and rural development projects began to sound (Pinstrup-Andersen, 1981; Swaminathan, 1981; Pinstrup-Andersen, 1982; Pinstrup-Andersen, 1983). The agriculture community was slow, even resistant, to incorporate nutritional concerns into their work, however, both because they felt they lacked the expertise to do so and because they felt nutritional issues were outside the realm of their responsibility (Berg and Austin, 1984). Though this trend has continued to the present day, renewed interest in finding ways to improve nutrition through agriculture has emerged in the past decade and has been slowly gaining momentum.

In 2004, for example, HarvestPlus was launched under the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI) as a biofortification program aiming to breed higher levels of iron, zinc and β -carotene into common staple crops such as maize, rice, wheat and sweet potato. The program has received a great deal of public attention (Foresight, 2011), most notably with respect to its successful development and promotion of the orange-fleshed sweet potato in Mozambique and Uganda (Yanggen and Nagujja, 2006; Low et al, 2007). The Feed the Future Initiative, launched in July 2009 at the G8 Summit in L’Aquila, Italy as the U.S. government’s global hunger and food security initiative, is specifically geared toward improving the health and nutrition of communities in low-income countries through improved agricultural development. To support this initiative, USAID recently awarded Tufts University \$15 million to serve as the Management

Entity for a new Nutrition Collaborative Research Support Program (CRSP) in Africa and Asia, the first Nutrition CRSP awarded by USAID in 25 years (Tufts University, 2010). The program will support research and interventions linking innovative agriculture and health strategies with the goal of improving nutrition outcomes for women and children in low-income countries. Just this year, IFPRI organized a massive conference in New Delhi, India bringing together over 1,000 researchers, policymakers, and practitioners in the fields of agriculture, nutrition and health to address the question of how to better leverage agriculture to improve nutrition and health outcomes. The conference produced eight papers and 21 briefs outlining a host of issues related to improving nutrition through agriculture, but more importantly, the event helped to raise visibility of the need for the agriculture, health and nutrition sectors to work together more effectively (Fanzo, 2011). Further research is planned in the coming years through the Research Program 4 proposal of the Consultative Group on International Agricultural Research (CGIAR) which addresses these exact linkages between agriculture, health and nutrition.

1.3 Conceptual pathways

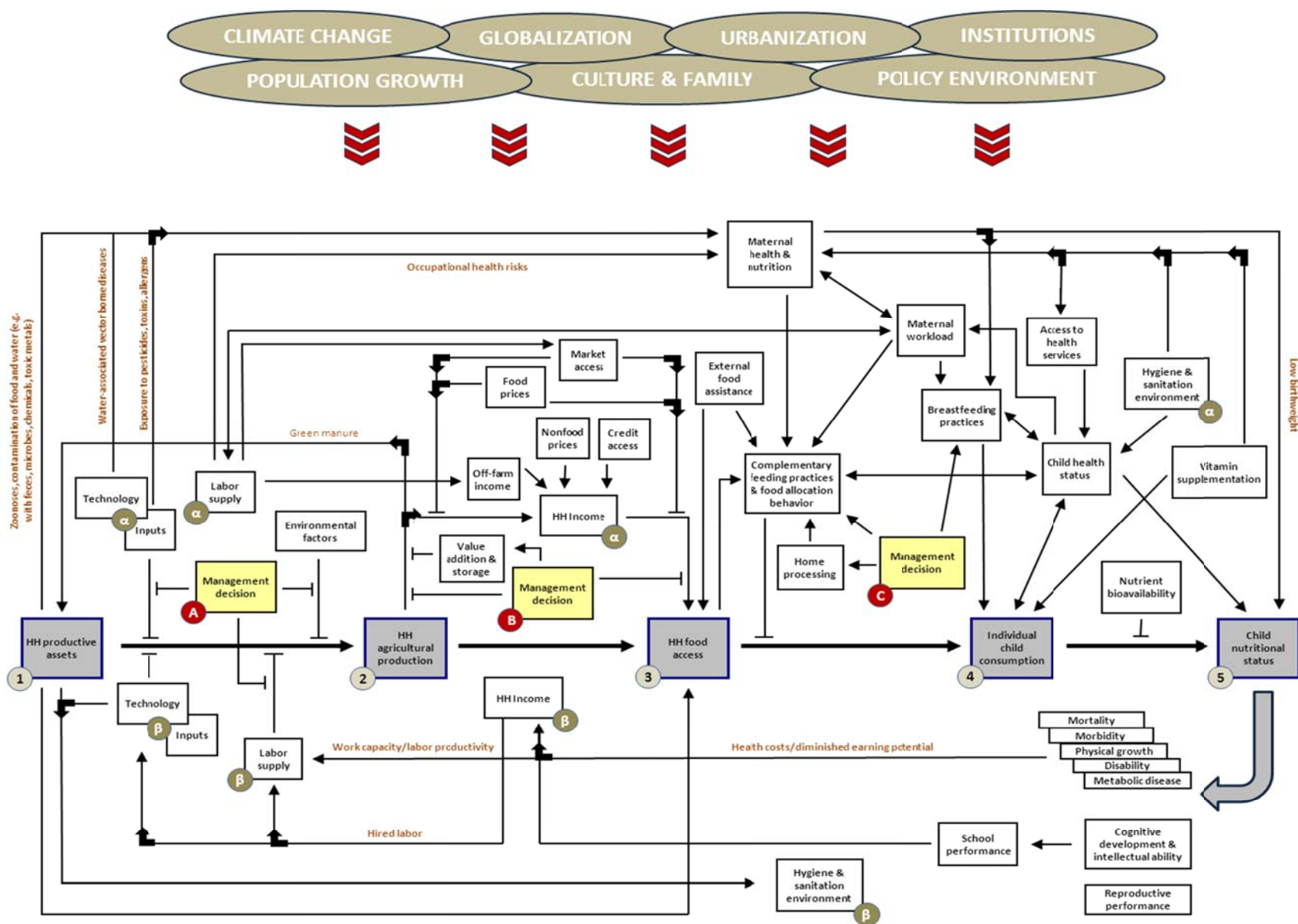
Numerous authors have outlined hypothesized linkages between food and agricultural systems and the nutrition and health outcomes that are generated in the context of these systems (Lipton and de Kadt, 1988; Pinstруп-Andersen, 1990; Haddad, 2000; Bonnard, 2001; Smitasiri, 2001; Johnson-Welch, 2002; Levin et al, 2003; Hawkes and Ruel, 2006; Pinstруп-Andersen, 2006; Pinstруп-Andersen, 2007; World Bank, 2007; Leroy et al, 2008; Shetty, 2009; Hoddinott, 2011). **Figure 1** is an attempt to synthesize the many common and distinct ideas presented in previous frameworks into a composite conceptual map highlighting the multiple pathways

through which agriculture and nutrition are connected. A more detailed explanation of this figure can be found in **Appendix A**.

The framework, emphasizing rural, semi-subsistence households and the nutrition outcomes of infants and young children within those households, is constructed around a central spine that reflects the hierarchical core concepts of food security defined at the World Food Summit of 1996 and reconfirmed in 2002: 1) food availability, 2) food access, and 3) food utilization (FAO, 1996; Webb et al, 2006). The “management decision” boxes in the framework represent household member decisions that may alter given outcomes. These decision making intersection points are perhaps most important to determining the direction and intensity of relationships, the trajectory of pathways, and the quality of outcomes within the framework. Several macro-scale factors also broadly influence many (if not all) of the relationships shown in the framework, but particularly the management decisions. These influences include climate change, globalization, urbanization, population growth, policy environments, institutions, and culture and family. Their effects on the pathways from agriculture to nutrition are not modeled directly in the conceptual framework because of their overarching influence and the difficulty in directly measuring and untangling their impact on those factors explicitly depicted.

Households exploit the productive assets available to them (e.g. land, water, timber, animals) to produce agricultural goods (e.g. food, feed, fiber, fuel, materials for shelter and medicinal plants). Available technology (e.g. tools and machinery, improved seeds, irrigation infrastructure), labor supply, the influence of the physical environment (e.g. pests, disease, weather events, climate conditions), and the management decisions farmers make to modify

these inputs and influences (e.g. decisions related to crop choice and cropping systems, rotations, use of cover crops and fallows, soil and pest management practices) all determine in part the capacity of households to translate productive assets into agricultural production. Few farming households in low-income countries today are purely subsistence farmers. Though their diets rely largely on their own production, these households also engage markets to some degree. Agricultural commodities are sold and food and other items are purchased. Therefore,



the agricultural goods produced by a household do not necessarily contribute to that household's food basket. Food prices, the prices of other non-food items, the policies that influence those prices (Pinstrup-Andersen, 1981), off-farm income, access to credit, markets, and storage and processing facilities are important factors shaping household marketing and purchasing decisions. These decisions and the individuals that make them can greatly influence the extent to which agricultural production and income affect household food access, food security, and nutrition.

Income controlled by women has a significantly greater positive effect on child nutrition and household food security than income controlled by men (Kennedy and Cogill, 1987; DeWalt, 1993; Hoddinott and Haddad, 1994; Katz, 1994; Quisumbing et al, 1995). Women typically spend a higher proportion of their income on food, education, household services and health care for children than men (Guyer, 1980; Garcia, 1991; Thomas, 1994; Thomas, 1997; Hallman, 2003). Therefore, women play the central role in translating household-level food security into individual-level security for children. In addition to their importance in the allocation of resources within the household, women are also the primary caregivers of children. The often-cited UNICEF conceptual framework on the causes of child malnutrition (UNICEF, 1990; see **Appendix B**) identifies "care" as one of the three underlying determinants of child malnutrition (in addition to household food security and health services and a healthy environment). The concept of care includes: 1) care for pregnant and lactating women, 2) breastfeeding and the feeding of very young children, 3) psychosocial stimulation of children and support for their development, 4) food-preparation and food storage behavior, 5) hygiene behavior, and 6) care

for children during illness, including health-seeking behavior (Engle, 1992). Proper care then lies at the nexus of child dietary intake and health status. As mothers' breastfeeding and complementary feeding practices largely determine the entirety of child diets in their first years and maternal care and health-seeking behaviors influence the hygiene and health status of young children, care practices serve as a fulcrum, determining the direction, vicious or virtuous, of the synergistic malnutrition-infection circle¹. **Figure 1** shows these linkages between household food access, the decisions caregivers make in response to this food access and the pathways from care practices and child health status to child nutritional status.

The pathways from agricultural production to health and nutrition, though in some cases relatively straightforward², are mediated by a great many economic, social and physical factors that add complexity to these relationships.³ This complexity is furthered by the reflexive nature of these relationships; that is, the pathways between agriculture and nutrition are not unidirectional. Poor nutrition and health also impact agriculture: undernourished workers and workers in poor health are less fit to work, which leads to decreased productivity, absenteeism, and a downward spiral of declining income that feeds back into health and nutrition outcomes (Pinstруп-Andersen, 2006; Haas and Brownlie, 2001; Larson et al, 2008). In the long-term, poor child nutrition leads to increased risk of death (Black et al, 2008; Pelletier et al, 1995), as well as

¹ See Scrimshaw and San Giovanni, 1997 and Woodward, 1998 for more information on the nutrition-infection synergy.

² Some of the potential direct health risks resulting from involvement in agriculture-related livelihoods stem from the use of agrochemicals (Lipton et al, 2006), foodborne diseases (Todd ECD and Narrod C, 2006), HIV/AIDS (Donovan and Massingue, 2007), malaria and water-associated diseases (van der Hoek, 2004; Mutero CM, 2006), zoonoses (Catelo MA, 2006; Mumford et al, 2007), and occupational health hazards (Cole D, 2006; Hurst, 2007).

³ Hawkes and Ruel point to numerous intermediary processes such as labor, environmental change, income generation, food and healthcare access that act in multiple directions to modify the health outcomes (e.g. undernutrition, vector-borne diseases, chronic diseases) resulting from agricultural supply chain factors (e.g. producers, systems, and outputs) (Hawkes and Ruel, 2006).

poor growth, impaired cognitive development, reproductive and physical work capacity, diminished school performance and income-earning potential and risk for several adult-onset chronic diseases (Semba and Bloem, 2001; Martorell and Haschke, 2001). These factors ultimately affect household labor and income and therefore potential agricultural output. Women's time allocation is another critically important pathway between agriculture and nutrition that is rarely explicitly identified as such, but that functions in both directions, helping to determine the quantity and quality of agricultural output as well as the quality of care received by infants and young children. Women, especially those in low-income households, are enormously burdened with work, dividing their time between agricultural labor, off-farm income-earning opportunities, domestic chores (e.g. collecting firewood and water, washing clothes), food preparation, child care responsibilities as well as care for themselves and elderly family members (McGuire and Popkin, 1989). Empowerment of women agriculturalists has been recognized as a key pathway from agriculture to nutrition (World Bank, 2007; Arimond et al, 2010). However, women's time allocation, a crucial aspect of empowerment, has not been sufficiently addressed; rather, "empowerment" as it has been used tends to emphasize improving women's agricultural productivity and income, both important goals, but with the potential to deleteriously affect women's time, particularly time dedicated to child care (see **Chapter 4** for a more detailed treatment of these questions). In fact, most studies assessing the effect of agricultural interventions on nutrition outcomes rarely measure the impact of these projects on women's time (Leroy et al, 2008). Among those that have assessed this impact, a project in Bangladesh that promoted vegetable or fish production in target households found a limited increased demand on women's time resulting from the intervention (Bouis et al, 1998),

however, in a study promoting improved dairy production, increases in women's income were accompanied by significant increases in demand on women's time (Mullins et al, 1996), whereas in a separate dairy intervention, little impact in the demand on women's time was observed though women's incomes were similarly unchanged (Begum, 1994).

1.4 The evidence base: solid intuition on shaky ground

In the journal *Lancet's* series on maternal and child undernutrition, Bhutta and others identify a menu of evidence-based interventions that are proven to reduce the global burden of undernutrition, particularly among children (Bhutta et al, 2008). Though strategies such as breastfeeding and handwashing promotion are included among these interventions, structural, behavior change-related solutions are not well represented on the list which includes: provision of balanced energy and protein supplements during pregnancy, multiple micronutrient supplementation during pregnancy, vitamin A supplementation of mothers and children, dispersible micronutrient preparations, deworming and use of helminthics during pregnancy, supplementation with iron-folate during pregnancy, and intermittent preventative treatment for malaria in pregnancy. Interventions to diversify diets or improve agricultural production and household agricultural incomes were omitted from the menu. The authors noted:

“Interventions to diversify diets by enhancement of agriculture and small-animal production (e.g. home gardening, livestock rearing, and dietary modifications) are potentially promising and culturally relevant, but in general, have only been implemented at a small scale, and have not been adequately assessed...dietary diversification strategies have not been proven to affect nutritional status or

micronutrient indicators on a large scale. In view of the weak evidence for the effects of these interventions on human nutrition, we did not attempt to estimate their effects” (p. 430; Bhutta et al, 2008).

Efforts to improve nutrition by diversifying diets, strengthening food systems and improving the diversity and efficiency of agricultural production have not been emphasized by the nutrition community. These efforts are often included in programs with the broader goals of sustainable development and community empowerment. Some suggest that these types of programs and investments may offer multiple benefits to rural communities through long-term, sustainable changes in food systems (Levin et al, 2003). Though weak, the empirical evidence base demonstrating improvements in nutrition resulting from agricultural interventions may misrepresent the true strength of the linkages between individuals’ interactions with agricultural systems and food production and the health and nutrition of those producing and consuming that food.

A recent review of the literature on the nutrition impacts of agricultural interventions found evidence of increased consumption of target foods promoted as part of agricultural interventions, but only weak evidence of an impact on child growth and micronutrient status (Masset et al, 2010). The authors conclude that, rather than demonstrating the inefficacy of these interventions, the lack of impact shown likely reflects the inadequate evaluation designs of these projects that limit their ability to properly assess nutritional impacts. Other recent reviews of this literature have reached similar conclusions, observing the common omission of nutritional indicators from the evaluation of agricultural interventions as well as the difficulty of

comparing studies with disparate objectives, project inputs, and highly variable quality of evaluation designs (e.g. many studies lack appropriate controls for confounding and selection bias or do not adequately specify their evaluation methods) (Ruel and Levin, 2000; Berti et al, 2004; Leroy and Frongillo, 2007; World Bank, 2007; Leroy et al, 2008; Arimond et al, 2010; Kwarazuka, 2010).

Five main types of interventions have predominated in this literature: 1) horticultural and home gardening projects, 2) animal-source food production (e.g. dairy and poultry production as well as aquaculture), 3) mixed horticultural and animal-source food production, 4) changes to cropping systems (e.g. intercropping and biofortification of staple crops), and 5) agricultural commercialization (e.g. shifting from subsistence production to production for the market, particularly production of non-staple and non-food crops such as sugar, tobacco, coffee, rubber, and fodder crops). Despite the widely-variable interventions included in the literature and the ambiguous results of the reviews of these projects, several key lessons have emerged that should guide the planning and design of future agricultural interventions seeking to improve nutrition outcomes.

1. Explicitly aim to improve nutrition

The most promising agricultural interventions to date for improving nutrition outcomes have been home gardening and food production projects with the explicit goal of improving household consumption of micronutrient-rich fruits, vegetables and animal-source foods. Helen Keller International's home gardening projects of the 1990s and subsequent Homestead Food

Production (HFP) programs that combine small-animal rearing with horticultural crops have served as a model for increasing intakes of micronutrient-rich foods using small-scale home production. Evaluations of these projects, though imperfect, provide some of the most rigorous data available for assessing the nutritional impacts of agricultural projects and indicate that consumption of targeted micronutrient-rich foods improved as a result of these projects in Bangladesh, Cambodia and Nepal (HKI, 1993; HKI, 2003a; HKI, 2003b; HKI, 2004a; HKI, 2004b; HKI, 2006; Olney et al, 2009). Specifying at the outset the goal of these projects to improve household intakes of fruits, vegetables and animal-source foods has contributed to them achieving such outcomes. Other home gardening and food production projects explicitly aiming to improve nutrition outcomes have shown similar success improving consumption of targeted, nutritious foods (Ngu et al, 1995; Solon et al, 1996; Smitasiri et al, 1999; Kidala et al, 2000).

2. Improving agricultural production and household income is not sufficient to achieve nutrition gains

The World Bank recently cited three myths about nutrition; the first two are particularly relevant: 1) malnutrition is primarily a matter of inadequate food intake, and 2) improved nutrition is a by-product of other measures of poverty reduction and economic advance (World Bank, 2006). While poor dietary intake is one of the immediate causes of child undernutrition, child health status is equally important and the underlying factors influencing these immediate causes include food, health and care. “Food” is a critical component of these three underlying determinants, but it is only one of the components. Incorporating into agricultural interventions activities aimed at changing behaviors related to child care and the health and

hygiene of children may increase the likelihood that these projects will improve nutrition outcomes (Berti et al, 2004).

Behavior change communication (BCC) strategies that have been shown to be effective in contributing to improved child feeding practices, health outcomes and child nutritional status in the context of stand-alone nutrition interventions (Caulfield et al, 1999; Dewey and Adu-Afarwuah, 2008; Ruel et al, 2008), have also been successfully employed in agricultural programs packaged with production and income-generating activities. In Mozambique for example, BCC was incorporated into a program promoting increased production, consumption and purchase of orange-fleshed sweet potato (OFSP). Program staff used creative strategies such as community theater, songs, games and recipe trials to educate caregivers on the importance of vitamin A in child diets and promote the increased feeding of OFSP to young children (Low et al, 2007). Participating households showed increased production of OFSP, increased child dietary intakes of vitamin A and improved child vitamin A status compared to control children. Numerous other agricultural programs in Africa, Asia and Latin America have demonstrated similar improvements to production and consumption of target foods by incorporating nutrition education into their intervention strategies (Greiner and Mitra, 1995; Phillips et al, 1996; Vijayaraghavan et al, 1997; Kidala et al, 2000; Faber et al, 2002). While an exclusive focus on improving food intakes is not sufficient to improve nutrition outcomes, neither are increases in household incomes sufficient without attention to other factors.

In the 1980s, a large number of studies examined the impact of agricultural commercialization on formerly subsistence farming families. Though nutrition indicators did improve in a small number of the few studies that examined them, improvements to child nutrition were not consistently associated with improvements to household income. In an evaluation of a shift from maize to commercialized sugarcane production in rural Kenya, for example, incomes of farmers participating in a sugarcane outgrowers' scheme were significantly higher than those of non-sugar farmers, but no changes in child anthropometry were observed (Kennedy and Cogill, 1987). Sugar income was seen as a "man's income"; in households where women controlled the income, a significantly higher proportion of household expenditures went toward food. In a similar scheme in the Philippines, sugar producers demonstrated higher incomes than farmers devoted to maize production, and indeed a strong association between income and height-for-age was seen for infants (but not for older children) (Bouis and Haddad, 1990). However, a doubling of income led to only modest gains in anthropometry, suggesting income increases need to be quite large to impact child nutrition⁴. Higher-priced calories were also purchased by higher-income households such that increases in caloric intakes were not commensurate with increases in income. Further studies have shown that improving incomes by displacing subsistence crops entirely or in large part with cash crops, without investing in nutrition education or other nutrition and health-related activities, does not necessarily lead to improved nutrition outcomes for children (Kurth, 1989; Fleuret and Fleuret, 1991). Increasing incomes may indeed not only have no impact on child *under*nutrition, but could exacerbate problems of *over*nutrition. Particularly in middle-income countries, but increasingly in sub-Saharan Africa,

⁴ National-level data from 12 developing countries also indicate that the income-malnutrition relationship is modest. Doubling of gross national product (GNP) per capita is associated with a decrease in the rate of underweight from 32 to only 23 percent (Haddad et al, 2002; World Bank, 2006).

where the so-called “nutrition transition” is rapidly shifting diets toward foods high in fats and sweeteners and lifestyles toward decreased physical activity levels, the problems of underweight and overweight coexist (Popkin and Gordon-Larson, 2004; Hawkes, 2006; Ziraba et al, 2009). This dual burden may exist even within the same household (Doak et al, 2000; Caballero, 2005). Strategies to improve household incomes then must account for the different nutritional vulnerabilities of communities, households and individuals.

3. Target nutritionally-vulnerable groups

The most nutritionally vulnerable populations may be excluded from interventions (Pacey and Payne, 1985), often unintentionally, simply due to poor project design or unintended consequences of intervention programs. For example, 1) credit schemes may require land ownership or other qualifying terms for loan access that the extremely poor cannot meet, 2) agricultural commercialization benefiting middle-class farmers may alter prices of non-commodity crops, thus reducing the buying power of poorer, non-commercialized farmers, 3) interventions requiring high inputs of labor may exclude poorer farmers with less time liquidity and less able to take on the risk of changing cropping patterns, and 4) community economic and social hierarchies may exclude the poorest or most marginalized individuals from contributing to decision-making processes in cooperatives or other participatory programs (Lunven, 1982). Even within appropriately targeted households, improper allocation of food resources to the most vulnerable family members (i.e. women of childbearing age and young children) can contribute to poor nutrition and health outcomes (Haddad et al, 1997; Behrman, 2001; Gittelsohn and Vastine, 2003). The service delivery, clinical-style interventions mentioned

previously in the *Lancet* series on maternal and child undernutrition clearly target pregnant women, infants and young children. Designers of agricultural interventions focused on structural changes to food systems and modifications to farmers' livelihoods could take a similar approach, carefully considering the extent to which an intervention might affect nutrition outcomes of vulnerable households and sub-groups within households, positively or negatively, and adjusting priorities accordingly.

4. *Women's control of decisions and resources is critical*

As discussed previously, income controlled by women is more likely to be spent on food⁵, education, health care and more generally to benefit the nutrition of children within the household. Improvements to gender equality, women's decisionmaking power and control of income have been shown to significantly improve nutrition outcomes for children (HKI, 1993; Marsh, 1998; Bloem et al, 1996; Smith et al, 2003).

Women's time, also discussed previously and given fuller treatment later in this dissertation (see **Chapter 4**), is a resource as important for women as income, if not more so, considering women's multiple roles as caregivers, farmers, herders, laborers, and domestic workers and the enormous amount of time the responsibilities of each of these roles require. Women are the main agricultural producers in many countries. In Southeast Asia, women supply up to 90 percent of the labor required for rice cultivation (IFPRI, 2011). They account for 70 percent of

⁵ Agricultural income is more likely to be spent on food if 1) incremental income is earned or controlled by women, 2) the income is received regularly (even in small amounts), 3) the income is in-kind, 4) nutrition education accompanies income-earning (Bonnard, 2001).

farm labor and perform 80 percent of food processing in Africa (Cramer and Wandira, 2010). In most contexts, however, time spent on paid and unpaid work is sharply divided between genders. In Tanzania for example, women devote much more time than men to unpaid activities such as household maintenance and care giving (Budlender, 2008; Fontana and Natali, 2008). They dedicate a similar amount of time as men to primary agricultural work, but men spend more time performing other types of paid work and engaging in learning and leisure activities. Similar trends are observed in many developing countries (Gupta, 2004; Charmes, 2006). Women, therefore, have numerous competing claims on their time, few of which are rewarded with income that they control. These competing claims demand tradeoffs that can have important nutritional consequences. Care of babies may be relegated to child siblings, children may be breastfed less often, time for food preparation may be limited resulting in less nutritious diets, agricultural production may suffer and women may avoid off-farm income-earning opportunities (Ilahi, 2000). Evidence suggests that women's workload constraints even limit the likelihood that family members, children in particular, will routinely access health services or receive medical attention in a timely manner (Blackden and Wodon, 2006).

Therefore, projects that require additional time by women may fail or face implementation difficulties because the additional time is not available (Popkin et al, 1980; Smitasiri and Dhanamitta, 1999). In contrast, agricultural interventions that are sensitive to the unique potential women possess to impact nutrition outcomes (whether through increased time for child care, enhanced nutrition knowledge, or control of household resources) have

demonstrated improvements in nutrition outcomes (Hagenimana et al, 1999; Mulokozi et al, 2000).

5. Agriculture may operate along multiple, distinct pathways to influence nutrition outcomes

Figure 1 discussed previously shows in detail the multiple pathways by which changes to agricultural systems may influence nutrition outcomes and the numerous intermediate and external factors that work to modify these pathways. However, the empirical evidence supporting these hypothesized connections between agriculture and nutrition is lacking. Leroy and others examine pathways of change specific to interventions promoting home gardening and animal production (Leroy et al, 2008). These pathways include production of micronutrient-rich foods, income from sale of products, household food consumption, women's income and control over resources, women's knowledge and awareness, women's time availability, child health, and child diet. The authors conclude that the pathways supported by the strongest evidence are increased production of micronutrient-rich foods leading to increased consumption of these foods at the household and child level. However, the evidence that this increased consumption leads to the improved health, growth and micronutrient status of children is weak. Again, the authors suggest that inadequate evaluation designs and the difficulty presented in comparing substantively different studies contributes to the lack of evidence supporting the nutritional impacts of these programs.

The World Bank, examining a larger range of interventions in its review of the literature (not just home gardening and animal production interventions), arrives at nearly the same conclusion; however, it assesses the evidence supporting five somewhat different pathways, including those operating at a macro-level: 1) increased consumption from increased food production, 2) increased income from the sale of agricultural commodities, 3) increased empowerment of women as agents instrumental to improved household food security and health and nutrition outcomes, 4) reductions in real food prices associated with increased food supply, and 5) agricultural growth, leading to increased national income and macroeconomic growth and to poverty reduction and improved nutrition outcomes⁶ (World Bank, 2007).

These two reviews, as well as the other reviews referenced thus far, clearly emphasize increasing agricultural production and increasing incomes (particularly for women, but also at the household level) as principal pathways through which nutritional improvement may be achieved by intervening in agricultural systems. And, because they are the stakeholders most capable of translating agricultural improvements into nutritional gains for children and households, the reviews prioritize the need to support and empower women and mothers in their multiple roles.⁷ The need to improve women's farming productivity, and increase their control of income and household decisions is particularly emphasized. However, while the role of women as caregivers is mentioned, explicit pathways from agriculture to care are not modeled. Furthermore, the concept of infant and young child feeding practices, a core component of care, is not addressed as a potential outcome influenced by agricultural systems

⁶ Programs and interventions related to pathways four and five were not included in this review.

⁷ The Masset et al, 2010 review does not discuss the importance of supporting or empowering women. Rather the program theory it outlines focuses strictly on adoption of new technologies (e.g. livestock, fisheries, biofortified crops).

and practices.

Child feeding encompasses a broad range of behaviors including breastfeeding practices, the quantity and quality of complementary foods fed to young children, the feeding environment and responsiveness of caregivers, and feeding during and after child illness (Dewey, 2003).

Some of the pathways mentioned previously, for example, child diets, women's knowledge and awareness, and women's time availability, are directly and indirectly related to child feeding.

Holistically considering the multiple dimensions that constitute the concept of infant and young child feeding, however, allows for program models to explicitly target that entire set of practices and examine the numerous avenues by which different aspects of agriculture and women's interactions with agriculture might impact those practices (e.g. the quality and quantity of agricultural production, ecosystem services and degradation, the feeding environment, women's workload and time demands, exposure to livelihood risks, sociocultural influences on choice and decisionmaking related to livelihoods, and maternal capacity).

The following chapters seek to address this gap in the literature by examining how the rural livelihoods of women farmers and their engagement with local agriculture, specifically in the context of semi-subsistence farming communities in the central highlands of Bolivia, affect the capacity of these women to care for and feed their young children.

1.5 Research aims & organization of content

The broad goal of this research is to determine the role that agriculture and rural livelihoods play in affecting the infant and young child feeding and care practices of women in the northern

Potosí region of the Bolivian Andes. Brief chapter descriptions and the specific research aims comprising this larger research objective are detailed below.

Chapter 2 briefly outlines the current epidemiology of nutrition in Bolivia, provides an historical perspective on the focus region of the country, northern Potosí, as well as a discussion of the institutional influences in the region, in particular, the programs of World Neighbors – Bolivia, a non-governmental organization and collaborating partner in this research.

Chapter 3 discusses the concept of infant and young child feeding (IYCF) in more depth and introduces the primary measurement tool used to assess IYCF practices in this research, namely, an infant and child feeding index. Presenting data collected from two quantitative household surveys, this chapter establishes the nature of child feeding practices in this region of Bolivia as well as the underlying relationships between these practices and child nutritional status. These relationships are foundational to understanding the nutritional importance of child feeding in this region and recognizing the deficiencies in these practices that are examined in subsequent chapters. The specific research aims presented in this chapter are to determine:

- 1) the relationship of an infant and child feeding index (ICFI) and its constituent components to child height-for-age Z-score (a measure of child nutritional status),
- 2) the association between the ICFI and two measures of dietary adequacy (dietary energy intake and micronutrient density adequacy), and

- 3) the relationship of a different set of indicators of infant and young child feeding, namely those recently published by the World Health Organization, to child growth and dietary adequacy.

Chapter 4 provides a detailed description of the agriculture-centered nutrition intervention that accompanied the broader data collection efforts of this research. The intervention focused on using women's livelihoods and their roles as agriculturalists as an entry point for improving IYCF practices. Qualitative data from focus group discussions and in-depth interviews with caregivers describe the complex dynamics of child feeding in this region of Bolivia, the multiple barriers women face to improving these practices, and the ability of caregivers to adopt new practices. The specific research aims presented in this chapter are to determine:

- 1) the extent and nature of the adoption of improved IYCF practices among mothers participating in the intervention,
- 2) the kinds of barriers mothers face to improving IYCF practices, which of these barriers are predominantly encountered and which, if any, are specifically related to agriculture,
- 3) the characteristics of households and mothers who face varying kinds of barriers to improving IYCF practices at varying degrees of intensity, and
- 4) the relationship between the barriers to improved child feeding encountered by mothers, both the number and kinds, to the adoption of improved IYCF practices.

Building upon the findings of Chapter 3 characterizing IYCF practices in this region of Bolivia, and the context of child feeding established in Chapter 4, particularly the capacity of women to adopt new practices and the barriers they face to doing so, Chapter 5 presents the results of the intervention program using a pre-post, quasi-experimental evaluation design based on quantitative household survey data. The primary outcome measure assessed is IYCF practices as measured by the infant and child feeding index. This chapter discusses how caregivers' feeding practices responded to the education efforts and activities of the intervention and proposes likely pathways through which the intervention functioned to impact these practices. The specific research aims presented in this chapter are to determine:

- 1) changes in the composite scores and constituent component scores of the ICFI resulting from the agriculture-centered nutrition intervention, and
- 2) changes in IYCF practices as measured by the World Health Organization infant and young child feeding indicators.

The final chapter, Chapter 6, provides a summary of integrative conclusions based on the findings of the research and spells out several policy recommendations as well as recommendations for future research examining the linkages between agriculture and nutrition.

References

- Arimond M, Hawkes C, Ruel MT, Sifri Z, Berti PR, Leroy JL, Low JW, Brown LR, Frongillo EA. Agricultural Interventions and Nutrition: Lessons from the Past and New Evidence. In: Combating Micronutrient Deficiencies: Food-Based Approaches (Thompson B, Amoroso L, eds.), pp. 41-75. Rome, Italy: Food and Agricultural Organization of the United Nations, 2010.
- Begum JM. The impact of dairy development on protein and calorie intake of pre-school children. *Indian J Med Sci.* 1994;48:61-4.
- Behrman, JR. Intrahousehold Allocation of Nutrients in Rural India: Are Boys Favored? Do Parents Exhibit Inequality Aversion? *Oxford Economic Papers* 2001;40(1):32-54.
- Berg A, Austin J. Nutrition policies and programmes: A decade of redirection. *Food Policy* 1984;9(4):304-312.
- Berti PR, Krusevec J, Fitzgerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition* 2004;7: 599-609.
- Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HPS, Shekar M. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008; 371: 417–40.
- Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 2008;371:243-60.
- Bloem MW, Huq N, Gorstein J, Burger S, Kahn T, Islam N, Baker E, Davidson F. Production of fruits and vegetables at the homestead is an important source of vitamin A among women in rural Bangladesh. *Eur J Clin Nutr* 1996;50: S62–67.
- Bonnard P. Increasing the Nutritional Impacts of Agricultural Interventions: Strategy and Policy Brief. Washington, DC: Food and Nutrition Technical Assistance Project, 2001.
- Bouis HE, Haddad LJ. Effects of Agricultural Commercialization on Land Tenure, Household Resource Allocation, and Nutrition in the Philippines. Research Report 79. Washington, DC: International Food Policy Institute, 1990.

Bouis HE, de la Briere B, Guitierrez L, Hallman K, Hassan N, Hels O, Quabili W, Quisumbing A, Thilsted S, Zihad Z, Zohir S. Commercial vegetable and polyculture fish production in Bangladesh: their impacts on income, household resource allocation, and nutrition. Washington, DC: International Food Policy Research Institute, 1998.

Caballero B. A Nutrition Paradox—Underweight and Obesity in Developing Countries. *New England Journal of Medicine* 2005;352(15): 1514-16.

Catelo MAO. Livestock and Health. In: *Understanding the Links between Agriculture and Health* (Hawkes C and Ruel M, eds.), 2020 Focus 13, Brief 9. Washington, DC: International Food Policy Research Institute, 2006.

Caulfield LE, Huffman SL, Piwoz EG. Interventions to improve intake of complementary foods by infants 6 to 12 months of age in developing countries: Impact on growth and on the prevalence of malnutrition and potential contribution to child survival. *Food and Nutrition Bulletin* 1999;20(2):183-200.

Cohen JM. *Integrated rural development : the Ethiopian experience and the debate*. Uppsala: Scandinavian Institute of African Studies, 1987.

Cole D. Occupational Health Hazards of Agriculture. In: *Understanding the Links between Agriculture and Health* (Hawkes C and Ruel M, eds.), 2020 Focus 13, Brief 8. Washington, DC: International Food Policy Research Institute, 2006.

Davies P. An Historical Perspective from the Green Revolution to the Gene Revolution. *Nutrition Reviews* 2003;61(6):S124–S134.

DeWalt K. Nutrition and the commercialization of agriculture. Ten years later. *Social Science and Medicine* 1993;36:1407-1416.

Dewey KG. *Guiding principles for complementary feeding of the breastfed child*. Washington, DC, Pan American Health Organization/World Health Organization, 2003.

Dewey KG, Adu-Afarwuah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Maternal and Child Nutrition* 2008;4:24-85.

Doak CM, Adair LS, Monteiro C, Popkin BM. Overweight and Underweight Coexist within Households in Brazil, China, and Russia. *The Journal of Nutrition* 2000;130(12):2965-71.

Donovan C, Massingue J. Illness, death, and macronutrients: Adequacy of rural Mozambican household production of macronutrients in the face of HIV/AIDS. *Food Nutr Bull* 2007;28:S331–8.

Engle PL. Childcare and nutrition. Theme Paper for the International Conference on Nutrition. New York: UNICEF, 1992.

Faber M, Spinnler AB, Venter SL. Increased Vitamin A Intake in Children Aged 2-5 Years Through Targeted Home-Gardens in a Rural South African Community. *Public Health Nutrition* 2002;5(1): 11-16.

FAO. Rome Declaration on World Food Security, World Food Summit. Rome: Food and Agriculture Organisation, 1996.

Fanzo J. IFPRI's 2020 conference on leveraging agriculture for improving nutrition and health: keeping the momentum and translating ideas into action. *Food Security*. Published online: 6 April 2011.

Field JO. Multisectoral nutrition planning: a post-mortem. *Food Policy* 1987;12(1):15-28.

Fleuret P, Fleuret A. Social organization, resource management, and child nutrition in the Taita Hills, Kenya. *Am Anthropol* 1991;93: 91-114.

Foresight. The Future of Food and Farming: Challenges and choices for global sustainability. Final Project Report. London: The Government Office for Science, 2011.

Garcia M. Impact of female sources of income on food demand among rural households in the Philippines. *Quarterly Journal of International Agriculture* 1991;30(2): 109-124.

Gittelsohn J, Vastine AE. Sociocultural and Household Factors Impacting on the Selection, Allocation and Consumption of Animal Source Foods: Current Knowledge and Application. *J Nutr* 2003;133:4036S-4041S.

Greiner T, Mitra SN. Evaluation of the impact of a food-based approach to solving vitamin A deficiency in Bangladesh. *Food and Nutrition Bulletin* 1995;16: 193-205.

Guyer J. Household budgets and women's incomes. African Studies Center Working Paper No. 28. Boston University, Boston, Mass., USA. 1980.

Haas JD, Brownlie T. Iron Deficiency and Reduced Work Capacity: A Critical Review of the Research to Determine a Causal Relationship. *J Nutr* 2001;131:676S-690S.

Haddad L, Hoddinott J, Alderman H. Introduction: The Scope of Intrahousehold Resource Allocation Issues. In: *Intrahousehold Resource Allocation in Developing Countries: Models, Methods and Policy*. (Haddad L, Hoddinott J, Alderman H, eds.), pp. 1-16. Washington, DC: International Food Policy Research Institute, 1997.

Haddad L. A conceptual framework for assessing agriculture-nutrition linkages. *Food and Nutrition Bulletin* 2000;21(4): 367-373.

Haddad L, Alderman H, Appleton S, Song L, Yohannes Y. Reducing Child Undernutrition: How Far Does Income Growth Take Us? FCND Discussion Paper 137. Washington, DC: International Food Policy Research Institute, 2002.

Hallman K. Mother-Father Resources, Marriage Payments, and Girl-Boy Health in Rural Bangladesh. In: *Household Decisions, Gender, and Development*. (Quisumbing A, ed), pp.115-120. Washington DC: IFPRI, 2003.

Harper AE, Payne PR, Waterlow JC. Human protein needs. *Lancet* 1973;301(7818):1518. IFPRI. *Green Revolution: Curse or Blessing?* Washington, DC: International Food Policy Research Institute, 2002.

Hawkes C, Ruel M. *Understanding the Links between Agriculture and Health*. Washington, DC: International Food Policy Research Institute, 2006.

Hawkes C. Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Global Health* 2006;2:4.

Helen Keller International/Asian Vegetable Research and Development Centre (Taiwan). *Home Gardening in Bangladesh: Evaluation Report of the Home Gardening Pilot Project*. Report. New York: HKI, 1993.

Helen Keller International. HKI's homestead food production program sustainably improves livelihoods of households in rural Bangladesh. *Homestead Food Production Bulletin*. Report No. 1. New York: Helen Keller International, 2003a.

Helen Keller International. Integration of animal husbandry into home gardening programs to increase vitamin A intake from foods: Bangladesh, Cambodia and Nepal. Asia-Pacific Special Issue. New York: Helen Keller International, 2003b.

Helen Keller International. Homestead food production program in Central and Far-Western Nepal increases food and nutrition security. Nutrition Bulletin. Report No. 2. New York: Helen Keller International, 2004a.

Helen Keller International. Improving household food security in Cambodia through integration of poultry production into existing home gardening programs. Homestead Food Production Bulletin. Report No. 4. New York: Helen Keller International, 2004b.

Helen Keller International. Homestead food production- an effective integrated approach to improve food security among the vulnerable char dwellers in northern Bangladesh. Homestead Food Production Bulletin. Report No. 4. New York: Helen Keller International, 2006.

Hoddinott J, Haddad L. Women's Income and Boy-Girl Anthropometric Status in the Côte d'Ivoire. World Development 1994;22(4):543-53.

Hoddinott J. Agriculture, Health, and Nutrition: Toward Conceptualizing the Linkages. 2020 Conference Paper 2. Washington, DC: International Food Policy Research Institute (IFPRI), 2011.

Hurst P. Health and child labor in agriculture. Food Nutr Bull 2007;28:S364–71.

Johnson-Welch C. Linking Agriculture and Nutrition: The Human Dimension. Washington, DC: International Center for Research on Women, 2002.

Jonsson U. The rise and fall of paradigms in world food and nutrition policy. (Commentary). World Nutrition 2010;1(3):128-158.

Katz E. The Impact of Non-traditional Export Agriculture on Income and Food Availability in Guatemala: An Intra-household Perspective. Food and Nutrition Bulletin 1994;15(4).

Kawarazuka N. The contribution of fish intake, aquaculture, and small-scale fisheries to improving nutrition: A literature review. The WorldFish Center Working Paper No. 2106. Penang, Malaysia: The WorldFish Center, 2010.

Kennedy ET, Cogill B. Income and Nutritional Effects of the Commercialization of Agriculture in Southwestern Kenya. Research Report 63. Washington, DC: International Food Policy Research Institute, 1987.

Kidala D, Greiner T, Gebre-Medhin M. Five-year follow-up of a food-based vitamin A intervention in Tanzania. *Public Health Nutrition* 2000;3: 425-31.

Kissinger H. Address at the opening of the World Food Conference. Rome. 5 November 1974.

Koppel B. Does Integrated Area Development Work? Insights from the Bicol River Basin Development Program. *World Development* 1987;15(2):205-220.

Kurth A. Agricultural development and nutritional status in Malawi. *Journal of Tropical Pediatrics* 1989;35: 250-4.

Larson BA, Fox MP, Rosen S, Bii M, Sigei C, Shaffer D, Sawe F, Wasunna M, Simon JL. Early effects of antiretroviral therapy on work performance: preliminary results from a cohort study of Kenyan agricultural workers. *AIDS* 2008;22(3):421-5.

League of Nations. Nutrition: Final Report of the Mixed Committee of the League of Nations on the Relation of Nutrition to Health, Agriculture and Economic Policy. Geneva, Switzerland: League of Nations, 1937.

Lele U. Remembering Robert McNamara: McNamara's Contribution to Food, Agriculture and Rural Development: Challenges It Poses for the Present Generation. Blog Entry. 2005. <http://www.umalele.org/content/view/178/32/>. Accessed July 15 2010.

Leroy JL, Frongillo E. Can Interventions to Promote Animal Production Ameliorate Undernutrition? *Journal of Nutrition* 2007;137: 2311-2316.

Leroy JL, Ruel M, Verhofstadt E, Olney D. The Micronutrient Impact of Multisectoral Programs Focusing on Nutrition: Examples From Conditional Cash Transfer, Microcredit with Education, and Agricultural Programs. Florence, Italy: Micronutrient Forum, Innocenti Process, 2008.

Levin CE, Long J, Simler KR, Johnson-Welch C. Cultivating Nutrition: A Survey of Viewpoints On Integrating Agriculture and Nutrition. Food Consumption and Nutrition Division Discussion Paper No. 154. Washington, DC: International Food Policy Research Institute, 2003.

Lipton M, de Kadt E. Agriculture-Health Linkages. The Institute of Development Studies, University of Sussex, Brighton, England. Geneva, Switzerland: World Health Organization, 1988.

Lipton M, Sinha S, Blackman R. Agricultural Technology and Health. In: Understanding the Links between Agriculture and Health (Hawkes C and Ruel M, eds.), 2020 Focus 13, Brief 3. Washington, DC: International Food Policy Research Institute, 2006.

Low JW, Arimond M, Osman N, Cungaara B, Zano F, Tschirley D. A Food-Based Approach Introducing Orange-Fleshed Sweet Potatoes Increased Vitamin A Intake and Serum Retinol Concentrations in Young Children in Rural Mozambique. *Journal of Nutrition* 2007;137: 1320-1327.

Lunven P. The nutritional consequences of agricultural and rural development projects. *Food Nutr Bull* 1982;4(3):17-22.

Marsh R. Building on traditional gardening to improve household food security. *Food, Nutrition and Agriculture* 1998;22: 4-14.

Martorell R, Haschke F, eds. Nutrition and Growth. Nestle Nutrition Workshop Series, Pediatric Program, vol. 47. Lippincott, Williams and Wilkins, Philadelphia, PA. 2001.

Masset E, Cornelius A, Haddad L, Isaza-Castro J. What is the impact of interventions to increase agricultural production on children's nutritional status?: A systematic review of interventions aiming at increasing income and improving the diet of the rural poor. DFID, 2010.

McGuire J, Popkin BM. Beating the Zero Sum Game: Women and Nutrition in the Third World. Part 1. *Food and Nutrition Bulletin* 1989;11(4):38-63.

McLaren DS. The Great Protein Fiasco. *The Lancet* 1974;304(7872):93-96.

Mullins G, Wahome L, Tsangari P, Maarse L. Impacts of intensive dairy production on smallholder farm women in coastal Kenya. *Human Ecology*. 1996;24:231-53.

Mulokozi G, Mselle C, Mgoba C, Mugyabuso JKL, Ndossi DG. Improved solar drying of vitamin A-rich foods by women's groups in the Singida District of Tanzania. Research Program. Report No. 5. Washington DC: International Center for Research on Women (ICRW)/ Opportunities for Micronutrient Interventions (OMNI), 2000.

Mumford E, Bishop J, Hendricks S, Embarek PB, Perdue M. Avian influenza H5N1: Risks at the human–animal interface. *Food Nutr Bull* 2007;28:S357–63.

Mutero CM, McCartney M, Boelee E. Agriculture, Malaria, and Water-Associated Diseases. In: *Understanding the Links between Agriculture and Health* (Hawkes C and Ruel M, eds.), 2020 Focus 13, Brief 6. Washington, DC: International Food Policy Research Institute, 2006.

Ngu T, Quang ND, Ha PH, Giay T, Badcock JC, FitzGerald S. A food based approach to nutrition improvement through household food security in Vietnam, with special reference to vitamin A deficiency. In: *Proceedings of 16th IVACG Meeting* (Chang Rai, ed.), pp. 77. Washington, DC: International Life Sciences Institute, 1995.

Olney DK, Talukder A, Iannotti LL, Ruel MT, Quinn V. Assessing Impact and Impact Pathways of a Homestead Food Production Program on Household and Child Nutrition in Cambodia. *Food and Nutrition Bulletin* 2009;30(4):355-69.

Pacey A, Payne P. *Agricultural Development and Nutrition*. Hutchinson. London. 1985.

Pelletier DL, Frongillo EA, Schroeder DG, Habicht JP. The effects of malnutrition on mortality in developing countries. *Bull WHO* 1995;73(4):443-448.

Phillips M, Sanghvi T, Suarez R, McKigney J, Fiedler J. The costs and effectiveness of three vitamin A interventions in Guatemala. *Social Science & Medicine* 1996;42: 1661-8.

Pinstrup-Andersen P. *Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches*. Washington, DC: World Bank, 1981.

Pinstrup-Andersen P. Introducing nutritional considerations into agricultural and rural development. *Food and Nutrition Bulletin* 1982;4:33-41.

Pinstrup-Andersen P. Incorporating nutritional goals into the design of international agricultural research. *Food Nutr Bull* 1983;5(3):47-56.

Pinstrup-Andersen P. Agricultural research and nutrition. *Food Policy* 1990;15:475-8.

Pinstrup-Andersen P. Commentary: Focus the global food system on health and nutrition goals. *Intl J Agricultural Sustainability* 2006;4(1):2-4.

Pinstrup-Andersen P. Agricultural research and policy for better health and nutrition in developing countries: a food systems approach. *Agricultural Economics* 2007;37(s1):187-198.

Popkin BM, Gordon-Larson P. The Nutrition Transition: Worldwide Obesity Dynamics and Their Determinants. *International Journal of Obesity* 2004;28(S3): S2-S9.

Prentice AM. Trials and Tribulations: Interpreting Unexpected Outcomes from Micronutrient Interventions. E.V. McCollum Lecture. Experimental Biology Meeting. American Society for Nutrition. Washington, DC, 10 April 2011.

Quinn VJ. Nutrition and National Development: An evaluation of nutrition planning in Malawi from 1936 to 1990. Doctoral dissertation. Wageningen Agricultural University Press, 1994.

Quisumbing AR, Brown L, Feldstein H, Haddad L, Pena C. Women: the key to food security. Washington DC, International Food Policy Research Institute. Food Policy Report. 1995.

Rivers JPW. The profession of nutrition – an historical perspective. *Proceedings of the Nutrition Society* 1979;38:225-231.

Ruel MT, Levin CE. Assessing the Potential for Food Based Strategies to Reduce Vitamin A and Iron Deficiencies: Reviewing the Evidence. Washington, DC: International Food Policy Institute, 2000.

Ruel MT, Menon P, Habicht JP, Loechl C, Bergeron G, Pelto G, Arimond M, Maluccio J, Michaud L, Hankebo B. Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial. *Lancet* 2008;371:588-95.

Scrimshaw NS, SanGiovanni JP. Synergism of nutrition, infection, and immunity: An overview. *Am J Clin Nutr.* 1997;66:464S–477S.

Semba RD, Bloem MW, eds. *Nutrition and health in Developing Countries*. Humana Press, Towata, NJ. 2001.

Sen AK. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Clarendon Press, 1981.

Shetty P. Incorporating Nutritional Considerations When Addressing Food Insecurity. *Food Security* 2009;1:431-440.

Smitasiri SK, San-gobwarchar K, Kongpunya P, Subsuwan C, Banjong O, Chitchumroonechokchai C, Rusami-Sopaporn W, Veeravong S, Dhanamitta S. Sustaining behavioural change to enhance micronutrient status through community and women-based interventions in northeast Thailand: vitamin A. *Food and Nutrition Bulletin* 1999;20: 243-51.

Smitasiri S. A comment on how the nutritional impact of agricultural innovations can be enhanced. *Food and Nutrition Bulletin* 2001;21:503-6.

Smith LC, Ramakrishnan U, Ndiaye A, Haddad L, Martorell R. The Importance of Women's Status for Child Nutrition in Developing Countries. In: *Household Decisions, Gender, and Development*. (Quisumbing A, ed), pp. 41-50. Washington DC: IFPRI, 2003.

Solon F, Briones H, Fernandez JR, Shafritz LB. Moving to a long-term strategy: increasing vegetable gardening and consumption in the Philippines. In: *Strategies for Promoting Vitamin A Production, Consumption and Supplementation* (Seidel RE, ed.). Four Case Studies. Washington, DC: Academy for Educational Development, 1996.

Swaminathan MS. Introducing nutritional considerations into agricultural and rural development. *Food Nutr Bull* 1981;3(3):30-36.

Thomas D. Like father, like son, or like mother, like daughter: Parental education and child health. *Journal of Human Resources* 1994;29(4):950-988.

Thomas D. Incomes, Expenditures and Health Outcomes: Evidence on Intrahousehold Resource Allocation. In: *Intrahousehold Resource Allocation in Developing Countries: Models, Methods and Policy*. (Haddad L, Hoddinott J, Alderman H, eds.), pp. 142-164. Washington, DC: International Food Policy Research Institute, 1997.

Todd ECD, Narrod C. Agriculture, Food Safety, and Foodborne Diseases. In: *Understanding the Links between Agriculture and Health* (Hawkes C and Ruel M, eds.), 2020 Focus 13, Brief 5. Washington, DC: International Food Policy Research Institute, 2006.

Tufts University. Tufts University Receives \$15 Million Grant from the US Agency for International Development. Press release. Retrieved from: <http://nutritioncrsp.org/press-release/>. 11 October 2010.

United Nations. The Millennium Development Goals Report 2010. New York: United Nations, 2010.

van der Hoek W. Malaria and agriculture. *Acta Tropica* 2004;89:1–166.

Vijayaraghavan K, Nayak MU, Bamji MS, Ramana GNV, Reddy V. Home gardening for combating vitamin A deficiency in rural India. *Food and Nutrition Bulletin* 1997;18: 337-43.

Webb P, Coates J, Frongillo EA, Rogers BL, Swindale A, Bilinsky P. Measuring Household Food Insecurity: Why It's So Important and Yet So Difficult to Do. *Journal of Nutrition* 2006;136(5):1404S-1408S.

Woodward B. Protein, calories, and immune defenses. *Nutr Rev* 1998;56:S84–S92.

World Bank. Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action. Washington, DC: World Bank, 2006.

World Bank. From Agriculture to Nutrition: Pathways, Synergies, and Outcomes. Washington, DC: Agriculture and Rural Development Department, World Bank. 2007.

Yanggen D, Nagujja S. The use of orange-fleshed sweetpotato to combat vitamin A deficiency in Uganda: A study of varietal preferences, extension strategies and post-harvest utilization. Vol. 2006-2. Social Sciences Working Paper Series. Lima, Peru: International Potato Center (CIP), 2006.

Zimmerman CC. Review of "Nutrition: Final Report of the Mixed Committee of the League of Nations on the Relation of Nutrition to Health, Agriculture and Economic Policy. *The Annals of the American Academy of Political and Social Science* 1938;198:238-239.

Ziraba AK, Fotso JC, Ochako R. Overweight and obesity in urban Africa: A problem of the rich or the poor? *BMC Public Health* 2009;9:46.

2. Setting the Context

2.1 Global malnutrition: a persistent burden

Despite the enormous expansion of the global economy in the past 60 years, unprecedented increases in global food production, and the myriad commitments of governments the world over to eliminate malnutrition and hunger, an estimated 925 million people are hungry today and nearly 150 million children are chronically undernourished—that is more than one quarter of all children aged 5 years or younger (de Onis et al, 2004; FAO, 2010). The disparity in this burden between rich and poor countries is stark: only 2.6 percent of preschool-aged children in developed countries are stunted⁸ while in developing countries, one-third are stunted with some countries bearing a substantially higher burden (e.g. nearly half all children less than 5 years of age in India are stunted). And vast numbers of children are still dying each year from malnutrition. Of the nearly 9 million children under the age of five that die each year, nutrition-related factors are estimated to account for one-third (Black et al, 2008) to one-half of these deaths (Pelletier et al, 1995).

Malnutrition manifests as a “triple burden” of energy and protein deficiency, micronutrient deficiencies, and overweight and obesity (Pinstrup-Andersen, 2011). Women of childbearing age and children are particularly vulnerable to the poor health outcomes associated with this triple burden. Chronic nutritional deficiencies in childhood can lead to an increased risk of morbidity and mortality, impaired growth and cognitive development, diminished reproductive

⁸ Stunting refers to a height-for-age Z-score of less than -2. Height-for-age is a measure of child growth which reflects a child’s nutritional status. Children who are growing particularly poorly compared to a population of healthy, well-nourished children as reflected by standard deviations from the mean of this height-for-age indicator are said to be “stunted”. Stunting reflects long-term, or chronic, deficits in growth resulting from a poor diet and/or poor health status (WHO, 1995).

and work capacity, as well as poor school performance, income-earning potential and increased risk of several adult-onset chronic diseases (see **Chapter 1**). Pregnant and lactating women, respectively, face increased nutritional requirements to support the growing fetus and to maintain adequate milk production (Hammond, 1997; Lawrence and Lawrence, 1999; Thornburg, 2006). These increased requirements place an additional burden on women who are often already overworked and undernourished. Poor maternal health and nutrition carries the insidious additional consequence of perpetuating intergenerational nutritional deprivation. Poor maternal weight gain during pregnancy, low pre-pregnancy weight, poor maternal health and short stature (resulting from childhood stunting), all nutrition-related outcomes, contribute to intrauterine growth retardation and low birth weight (Kramer, 1987). Low birthweight children in turn are at an increased risk of infant mortality, impaired growth, increased morbidity, and poor health outcomes later in life (Wilcox and Russell, 1983; Barker, 1994; Lira et al, 1996; Laurentino et al, 2005).

So-called “hidden hunger”, or deficiencies in essential micronutrients, particularly vitamin A, iron, zinc and iodine—the most common deficiencies globally, also affect women and children disproportionately, leading to higher infant and child mortality rates, impaired mental development, frequent infections, and increased risk of chronic diseases in children as well as increased risk of mortality and perinatal complications for pregnant women (Micronutrient Initiative, 2009). Vitamin A and zinc deficiencies alone are responsible for 1.1 million child deaths annually and iron-deficiency anemia is associated with 115,000 women’s deaths each year, one-fifth of the total maternal mortality burden (Black et al, 2008; UNICEF, 2008).

Excessive caloric intake is an increasingly common nutrition issue throughout the globe as well. Approximately 1.0 billion adults are overweight and a further 475 million are obese; overweight and non-communicable diseases, many related to diet, account for about 46 percent of the global burden of disease (International Obesity Task Force, 2010; WHO, 2002). As mentioned in the previous chapter, overweight and underweight conditions can coexist in the same countries, and even in the same households (Doak et al, 2005), suggesting that for many families, inadequate food access at the household level is not the primary determinant of child undernutrition (World Bank, 2006).

2.2 The critical “window of opportunity”

The period from pre-pregnancy through the first two years of life is often referred to as the “window of opportunity” for addressing undernutrition (World Bank, 2006)⁹. Child growth faltering that begins in the first months after birth continues until approximately 24 months of age, thereafter remaining reasonably stable (Victora et al, 2010). These early growth deficits and the developmental consequences that accompany them are largely irreversible (Martorell et al, 1994). Therefore, it is critically important to safeguard the health and nutrition of women prior to becoming pregnant, during the course of their pregnancy and the post-partum lactation period, in addition to ensuring infants and young children receive appropriate care and access to a healthy environment during their first two years of life. The nutritional requirements are greatest for women and children during these periods of time; however, these needs are often not met. Infants and young children in particular are highly vulnerable to infectious diseases

⁹ This window of time is also sometimes referred to as the “first 1,000 days” (Clinton, 2011).

and the poor feeding practices of caregivers, upon whom they are almost entirely dependent to satisfy their nutritional needs. Infant and young child feeding (IYCF) practices then, a component of “care” which, along with household food security and health environment constitute the underlying determinants of child undernutrition (see **Appendix B**), are one of the most important factors influencing the proper growth and development of a child. These practices are in many ways the post-partum analog to the placenta while the child is in the womb. In both cases, the growth and development of the fetus (via the placenta) and the child (via proper feeding and care practices) are dependent on the mother, while the mother’s ability to adequately provide the necessary nourishment (whether through transfer of nutrients from maternal tissue to fetal tissue, or through breastmilk and complementary foods) is impacted by her own health and nutrition status.

2.3 Latin America and Bolivia in context

As a region, Latin America has seen substantial improvements in health and nutrition indicators in recent years and has fared considerably better than sub-Saharan Africa and Asia. Between 2000 and 2008, child mortality declined by 4.6% annually in the Americas compared to the global average of 2.3%, 3.8% in South-East Asia and only 1.8% in Africa¹⁰ (WHO, 2010). The child mortality rate in South-East Asia is three times the rate observed in the Americas, and in Africa, the rate is seven times that of the Americas. Similarly, the percentage of stunted children under five years of age in South Asia was nearly three times that of Latin America and the Caribbean between 2000 and 2006 and in Africa the percentage was more than double the percentage in

¹⁰ World regions refer to WHO regions.

Latin America (see **Table 1**).

Table 1. Percentage of children aged <5 years stunted and underweight in select countries and world regions.

	Stunted			Underweight		
Select countries¹	1990-1999	2000-2009	% change	1990-1999	2000-2009	% change
Bolivia	33.1	27.1	-18.1	5.9	4.3	-27.1
Peru	31.6	29.8	-5.7	5.7	5.4	-5.3
Colombia	19.7	16.2	-17.8	6.3	5.1	-19.0
Guatemala	53.1	54.3	2.2	20.3	17.7	-12.8
India	51.0	47.9	-6.1	44.4	43.5	-2.0
Malawi	55.8	53.2	-4.7	24.4	15.5	-36.5
World regions²	2000-2006		% change	1990	2006	% change
South Asia	46		N/A	54	46	-14.8
Sub-Saharan Africa	38		N/A	32	28	-12.5
Latin America/Caribbean	16		N/A	13	8	-38.5
Developing countries	32		N/A	32	27	-15.6

¹Data source: WHO, 2010

²Data source: UNICEF, 2007

However, Bolivia, a landlocked nation of slightly more than nine million people in the Andean region of South America, remains well below Latin American regional averages for most health, nutrition and development indicators. For example, according to the FAO, Bolivia has the

highest prevalence of undernourishment in all of Latin America¹¹ (FAO, 2010). It also has the lowest dietary energy supply (2090 kcal/person/day) of any of its neighboring countries. Compared to the regional average of 18 child deaths per 1,000 live births, the under-five mortality rate in Bolivia is considerably poorer at 54 per 1,000 live births (WHO, 2010). **Table 1** also shows that the percentage of stunted (though not underweight) preschool-aged children in Bolivia is significantly greater than the average for the Latin America and Caribbean region. Life expectancy at birth in Bolivia (for both sexes combined) is 67 years compared to 76 years for the region while the 67 percent of the population using improved drinking water sources in the country is nearly 20% below the regional average. Disparities in rural indicators of health, nutrition and development within Bolivia are even starker.

Infant mortality rates in some rural areas still exceed 80 deaths per 1,000 live births (PAHO, 2007a) compared to the national average of 46 deaths per 1,000 live births (WHO, 2010). The percentage of stunted children less than 5 years of age in rural regions of Bolivia (37%) is twice the percentage in urban areas (WHO, 2007), while the prevalence of poverty and extreme poverty in rural areas is 77.3% and 63.9%, respectively, and 50.9% and 23.7%, respectively in urban areas (INEB, 2007). Thirty-four percent of urban dwellers have access to improved sanitation compared to fewer than 10 percent of rural households (WHO, 2010). Though urbanization has been rapidly expanding in recent years, more than a third of the population still resides in rural areas dependent upon semi-subsistence agriculture as a form of livelihood (PAHO, 2007b).

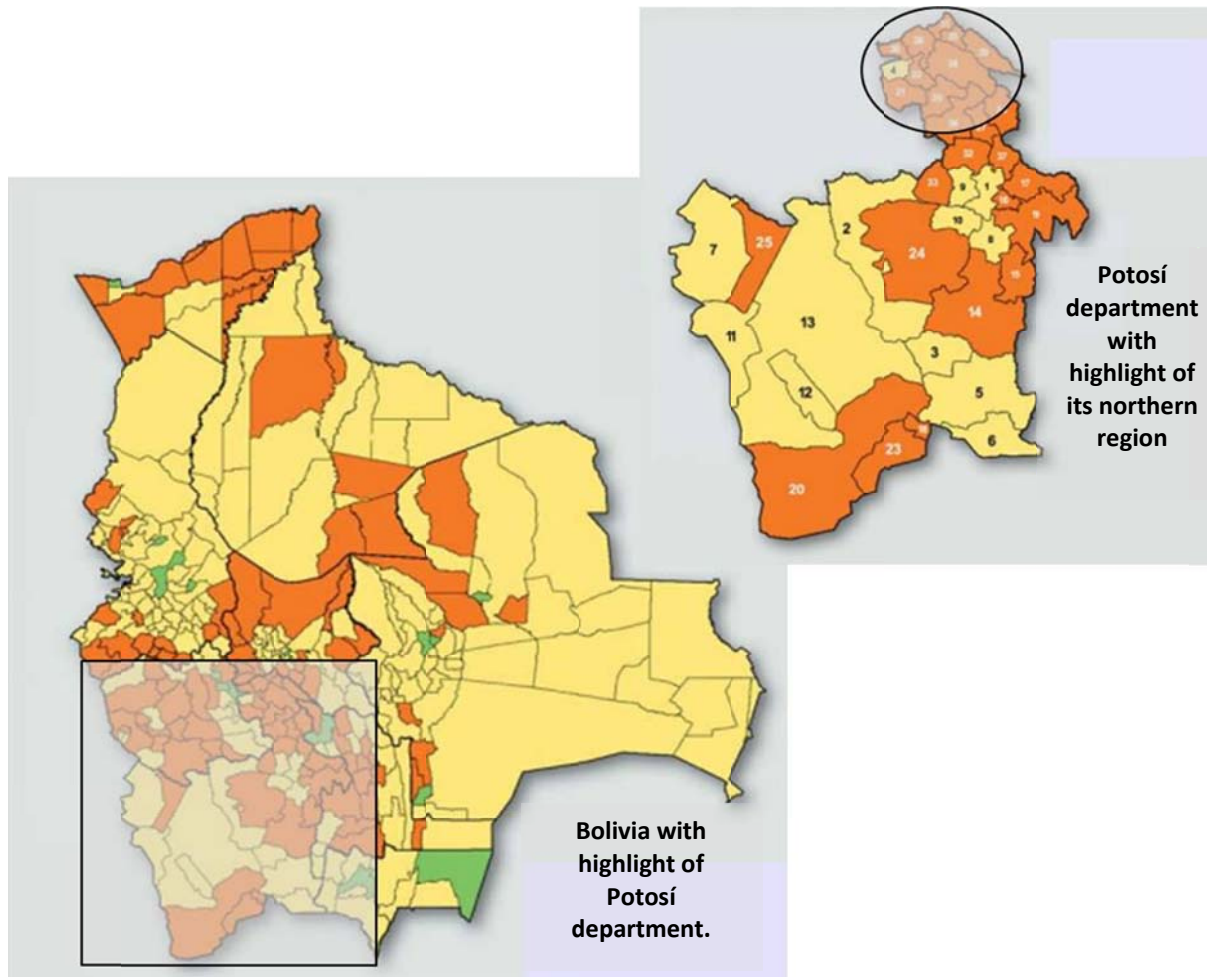
¹¹ “Undernourishment”, as defined by the FAO, “exists when caloric intake is below the minimum dietary energy requirement (MDER). The MDER is the amount of energy needed for light activity and a minimum acceptable weight for attained height, and it varies by country and from year to year depending on the gender and age structure of the population” (FAO, 2010).

The northern region of the department of Potosí is one such agriculturally-dependent rural area and is one of the poorest parts of Bolivia. **Figure 2** highlights the Potosí department, one of the largest departments in Bolivia both in terms of population (700,000 people) and land area (nearly 120,000 square kilometers), situated in the southwest corner of the country and encompassing a diverse spectrum of geographies from lithium-rich salt flats to highland tin and silver mining regions (INEB, 2001). The research herein was conducted in two municipalities of northern Potosí, Sacaca and San Pedro de Buena Vista, located in the region in **Figure 2** extending northward along the fingerlike strip of mountains marking the northeast boundary of the department. East of Bolivia's famous high plateau, or *altiplano*, northern Potosí lies within the range of mountains known as the *Cordillera Real* that contains a complex system of fertile plains and river valleys stretching from more than 4,200 meters above sea level to less than a kilometer above sea level (Klein, 2003). Humans have inhabited this region of Bolivia since pre-Columbian times, a region characterized by numerous environmental stresses including hypobaric hypoxia, alternating extremes of heat and cold throughout the day and night, respectively, and intense wind and precipitation (Haas et al, 1982). The present-day descendants of these ancient inhabitants have demonstrated physiologic adaptations to deal with such stresses (Haas et al, 1980; Moore et al, 1998). They also domesticated plants and animals specifically adapted to the cold, dry climate of the highlands including quinoa (*Chenopodium quinoa*) —an increasingly important export crop in present-day Bolivia (Romero and Shahriari, 2011), Andean lupin (*Lupinus mutabilis*), oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*) and many other cereal grains, root crops, fruits and vegetables (National Research Council, 2005). Most important, of course, was the domestication of the potato that occurred

some time between 7,000 and 10,000 years ago, not specifically in this region of Bolivia, but in what is now southern Peru (Hawkes, 1990). The potato supported the growth of the ancient pre-Incan Aymara and Incan civilizations in this region of the world, quite literally fueled the far-flung military campaigns of the Incan army, fed the Spanish-enslaved laborers of the region's 16th century mining operations, and has risen to become the world's fourth-largest food crop (Pollan, 2001). The natural pastures of the Andean highlands also allowed for the domestication of a variety of cameloids including llama, alpaca and *vicuña* which served as a source of wool, meat, fertilizer and heat (Klein, 2003).

The Spanish conquests of the late fifteenth and early sixteenth centuries radically disrupted traditional Andean land use and exchange systems that relied upon vertical ecological integration both within communities (to buffer against environmental risks) and between highland and lowland regions (to bolster the limited production potential of the *altiplano*; e.g. root crops, meat, and wool produced in the highlands were traded for coca, maize, fish, fruits and beans produced in the tropical lowland valleys) (Klein, 2003; Kerssen, 2010). These systems of integration, though diminished during the colonial period, managed to survive both centuries of Spanish domination and more recent movements toward industrial monoculture farming. In fact, the vestiges of Incan agricultural practices are conspicuously present throughout Bolivia today, and particularly in northern Potosí. The extensive agriculture that has been practiced for millennia in this region, that is, the harvesting of nutrients from a wide catchment area surrounding communities to distribute environmental and climatic risk, is still the predominant agricultural strategy in northern Potosí (Vanek, 2010).

Figure 2. Map of Bolivia with highlight of the Potosí department and its northern region¹.



Data source: Ministerio de Salud y Deportes Bolivia, 2009

¹Darkly shaded regions represent areas with a low health index score.

Communities cultivate fields near to and far from their homes, varying the intensity of crop management, but maintaining production in multiple sites. Crops include potatoes, wheat and barley (both introduced by the Spanish), maize, rye, a large number of native root crops, fava bean, peas, Andean lupin, and forage crops. Nearly all families also raise herd animals that serve as a source of soil nutrients for crop cultivation, meat for consumption, and a “bank

account” through which families can obtain cash from the sale of animals. Sheep, also introduced by the Spanish, are mixed with goats and llamas while at lower elevations cattle are also reared.

Though many ancient agricultural practices, local adaptive strategies and cultural traditions have survived in this area of Bolivia, the Quechua- and Aymara-speaking inhabitants of northern Potosí still face numerous livelihood barriers including severely degraded soils, harsh and unpredictable weather, and economic isolation. Access to large urban and even smaller regional markets requires traveling great distances, often on foot, and investing scarce resources of time and money that households can ill afford to spare. Health services are inadequate, in large part due to poorly-trained and poorly-equipped staff, low retention rates, and the difficulty in reaching communities scattered among the distant mountains and foothills. These factors contribute to the high prevalence of extreme poverty, household food insecurity, and high rates of child mortality in the region (Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006).

2.4 World Neighbors: strengthening community capacity from the ground up

Perhaps most well-known for their grassroots approach to agricultural development (Bunch, 1982), World Neighbors was founded as a small international development organization in 1951. It now operates in 13 countries with the aim of eliminating hunger, poverty and disease by focusing on participatory capacity building and entire communities rather than emphasizing single issues or providing direct handouts of food or material aid. World Neighbors-Bolivia

(WNB) has had a sustained presence in the northern Potosí region of Bolivia for more than 20 years. Their work there for many years primarily centered on improving agricultural production of smallholder farmers—helping farmers to identify improved varieties and promoting adoption of better crop and soil management practices. To achieve this, they employed community promoters, or *promotores*, to facilitate programming efforts. However, in the past decade, the organization increasingly began to focus on health issues alongside their agriculture programs, in particular, family planning. Responding to the enormous burden on women they observed in the region driven by large family sizes, little control by women over reproductive decisions, and numerous work responsibilities, WNB hired local nurses to lead family planning-related educational sessions in communities, administer birth control injections and assist women in receiving tubal ligations.

In 2005, the organization first began to incorporate explicit nutritional objectives into their programs. “Promoting Food Security through Legumes” was a program that sought to 1) expand the role of green manures, forages, and legume grains in crop rotations, 2) strengthen community organizations and local capacities for agricultural innovation, and 3) improve maternal and child nutrition. The program envisioned changes in smallholder farmers’ cropping systems as a catalyst for improved soil fertility, higher productivity, more diverse diets and reduced child undernutrition. This in the context of a larger movement in Bolivia to revalue indigenous crops (Kerssen and McInerney, 2011) and eliminate undernutrition, namely through the national government’s Zero Malnutrition program, a program launched in 2006 with the backing of President Evo Morales that promoted a large number of nutrition interventions with

varying degrees of implementation success, including a fortified, complementary food product for children known locally as *Nutribebé* (Hoey and Pelletier, 2011; Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2011). The research presented here builds upon the initial efforts of the WNB legume promotion program to understand the dietary deficiencies of adults and children, the infant and young child feeding practices of mothers, as well as the nutritional status of young children in northern Potosí (Berti et al, 2010; Cruz et al, 2010).

In 2008, WNB came under new leadership and legumes were no longer viewed as a triple solution to problems of soil health, community innovation and human health. Rather, World Neighbors' traditionally holistic focus on people, communities and social change was re-embraced (World Neighbors, 2008) with the intent to confront the pervasive child undernutrition of northern Potosí by examining with communities the multifaceted nature of the problem and its many determinants. Advancing the previous gains made in promotion of increased legume production and consumption certainly remained a priority, however, community-led solutions, particularly those geared toward addressing the social determinants of undernutrition were now emphasized.

This participatory approach is not common among non-governmental organizations (NGOs) in northern Potosí—a region rife with such organizations carrying out all manner of development projects. The *modus operandi* of many of these organizations is to provide material assistance to communities whether in the form of housing, micro-irrigation infrastructure, greenhouses, seed, animals, food supplements, feeding bowls, even satchels, vests and floppy hats. After

nearly two decades of exposure to the work of NGOs and the funding cycles of short-term development projects, communities in northern Potosí have become accustomed to the top-down, handout-heavy approaches of these organizations. They are also quite astute—they realize their position of power in the NGO relationship lies in their “need” for assistance (i.e. the ostensible reason for requesting funds from a donor: to right some wrong, fill some need, improve some outcome). Many communities exploit this fact by ensuring that they will benefit materially by project’s end, that is, before the one- to two-year funding life of the project runs out and the NGO vanishes. This analysis may sound overly critical or simplistic, and certainly not all communities and NGOs in the region function in this way, in fact, despite the abundance of NGOs in the region, many of the more isolated communities rarely if ever encounter them, and the individual programs and approaches of a given NGO may vary greatly. However, the relationship described between NGOs and communities is quite commonly encountered in northern Potosí and the culture of institutional dependency that permeates the region presented challenges to the research team when arriving in communities offering only capacity building and the opportunity for community-led social change. Despite these challenges, rarely did entire communities refuse the opportunity to work with World Neighbors. In those rare instances, the women, for whom the project’s potential benefits were greatest, were nearly always eager to participate, but were usually overruled by the male authorities in communities seeking more tangible deliverables.

References

Barker DJP. Mothers, Babies, and Disease in Later Life. London: BMJ, 1994.

Berti PR, Jones AD, Cruz Y, Larrea S, Borja R, Sherwood S. Assessment and characterization of the diet of an isolated population in the Bolivian Andes. *American Journal of Human Biology* 2010;22:741-749.

Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 2008;371:243–60.

Bunch R. Two Ears of Corn: A Guide to People-Centered Agricultural Improvement. Oklahoma City: World Neighbors, 1982.

de Onis M, Blössner M, Borghi E, Morris R, Frongillo EA. Methodology for estimating regional and global trends of child malnutrition. *International Journal of Epidemiology* 2004;33:1260–1270.

Clinton HR. Remarks at Food Security Event at the Food and Agriculture Organization. Rome, Italy. 6 May 2011.

Comité Técnico del Consejo Nacional de Alimentación y Nutrición. Desnutrición Cero al 2010: compromiso multisectorial (Primera Aproximación). La Paz, Bolivia: Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006.

Comité Técnico del Consejo Nacional de Alimentación y Nutrición. Informe Anual Gestión 2010. Programa Multisectorial Denutrición Cero. Draft copy. 2011.

Cruz Y, Jones AD, Berti PR. Prácticas de Lactancia Materna, Alimentación Complementaria y Cuidados del Infante en el Norte de Potosí – Bolivia. *Archivos Latinoamericanos de Nutrición* 2010;60(1):7-14.

Doak CM, Adair LS, Bentley M, Monteiro C, Popkin BM. The Dual Burden Household and the Nutrition Transition Paradox. *International Journal of Obesity* 2005;29:129-36.

Food and Agriculture Organization. The State of Food Insecurity in the World 2010. Rome, Italy: FAO, 2010.

Food and Agriculture Organization. FAO Hunger Map 2010: Prevalence of undernourishment in developing countries. FAOSTAT 2010. www.fao.org/hunger. [Accessed 10 May 2011].

Haas JD, Frongillo EA, Stepick CD, Beard JL, Hurtado L. Altitude, Ethnic and Sex Difference in Birth Weight and Length in Bolivia. *Human Biology* 1980;52(3):459-477.

Haas JD, Moreno-Black G, Frongillo EA, Pabon J, Pareja G, Ybarnegaray U, Hurtado L. Altitude and Infant Growth in Bolivia: A Longitudinal Study. *American Journal of Physical Anthropology* 1982;59:251-262.

Hammond KA. Adaptation of the maternal intestine during lactation. *J Mammary Gland Biol Neoplasia* 1997;2:243.

Hawkes JG. *The Potato: Evolution, Biodiversity, and Genetic Resources*. London: Belhaven Press, 1990.

Hoey L, Pelletier DL. Bolivia's multisectoral Zero Malnutrition Program: Insights on commitment, collaboration, and capacities. *Food and Nutrition Bulletin* 2011;32(2):S70-S81.

Instituto Nacional de Estadística de Bolivia. Population Census. 2001.

Instituto Nacional de Estadística de Bolivia. Indicadores de Pobreza Desigualdad y Desarrollo Humano. 2007. <http://www.ine.gob.bo/indice/EstadisticaSocial.aspx?codigo=30601>. [Accessed 10 May 2011].

International Obesity Task Force. 2003. International Obesity Task Force Press Statement. [<http://www.iaso.org/iotf/obesity/obesitytheglobalepidemic/>]. Accessed on 13 May 2011.

Kerssen T. Bolivia Reclaiming Food Sovereignty, Part I: The Resurgence of Native Foods. *Food First: Institute for Food and Development Policy*. Blog. 24 August 2010. [Accessed 11 May 2011].

Kerssen T, McInerney C. PROINPA: Conserving diversity for food sovereignty in Bolivia. *Food First*. 27 April 2011. <http://www.foodsovereigntyours.org/2011/04/proinpa-conserving-diversity-for-food-sovereignty-in-boliva/>. [Accessed 11 May 2011].

Klein HS. *A Concise History of Bolivia*. Cambridge, United Kingdom: Cambridge University Press, 2003.

Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. *Bulletin of the World Health Organization* 1987;65(5) 663–737.

Laurentino GEC, Arruda IKG, Raposo MCF, Batista Filho M. Height deficit in school aged children: a multivariate analysis of possible risk factors, Pernambuco – 1997. *Archivos Latinoamericanos de Nutrición* 2005;55:144–153.

Lawrence RA, Lawrence RM. *Breastfeeding: A Guide for the Medical Profession*. St. Louis: Mosby, 1999.

Lira PIC, Ashworth A, Morris SS. Low birth weight and morbidity from diarrhea and respiratory infection in northeast Brazil. *Journal of Pediatrics* 1996;128:497–504.

Martorell R, Khan KL, Schroeder D. Reversibility of Stunting: Epidemiological Findings in Children from Developing Countries. *European Journal of Clinical Nutrition* 1994;48:S45-S57.

Micronutrient Initiative. *Investing in the future: A united call to action on vitamin and mineral deficiencies*. Global Report 2009. Ottawa, Ontario: Micronutrient Initiative, 2009.

Ministerio de Salud y Deportes del Estado Plurinacional de Bolivia. *Bolivia: Índice de Salud Municipal 2009*. La Paz, Bolivia: Ministerio de Salud y Deportes del Estado Plurinacional de Bolivia, 2009.

Moore LG, Niermeyer S, Zamudio S. Human adaptation to high altitude: Regional and lifecycle perspectives. *American Journal of Physical Anthropology* 1998;107(27):25-64.

National Research Council. *Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation*. National Research Council, 2005.

PAHO. *Health Situation Analysis and Trends Summary*. Pan American Health Organization, 2007a.

PAHO. *Health Situation in the Americas: Basic Indicators*. Pan American Health Organization, 2007b.

Pinstrup-Andersen P. *The Food System and Its Interaction with Human Health and Nutrition*. 2020 Conference Brief 13. Washington, DC: International Food Policy Research Institute, 2011.

Pollan M. *The Botany of Desire: A Plant's-Eye View of the World*. Toronto: Random House, 2001.

Romero S, Shahriari S. Quinoa's Global Success Creates Quandary at Home. *The New York Times*. 19 March 2011.

Thornburg KL, Bagby SP, Giraud GD. Maternal Adaptation to Pregnancy. In: Knobil and Neill's *Physiology of Reproduction*, 3rd ed. (Neill JD, ed.), pp. 2899-2923. Elsevier, 2006.

UNICEF. *Progress for Children: A World Fit for Children Statistical Review* (No. 6). Geneva, Switzerland: UNICEF, 2007.

UNICEF. *Progress for Children: A Report Card on Maternal Mortality*. New York: UNICEF, 2008.

Vanek S. Soil gradients and legumes in mountain agroecosystems: N and P cycling and legume functional attributes in the Bolivian Andes. Doctoral dissertation. Cornell University, Ithaca, NY, 2010.

Victora CG, de Onis M, Hallal PC, Blössner M, Shrimpton R. Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions. *Pediatrics* 2010;125:e473-e480.

Wilcox AJ, Russell IT. Birthweight and perinatal mortality: II. On weight-specific mortality. *International Journal of Epidemiology* 1983;12:319-25.

World Bank. *Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action*. Washington, DC: World Bank, 2006.

World Health Organization. *Physical Status: The Use and Interpretation of Anthropometry*. Report of a WHO Expert Committee. Geneva, Switzerland: World Health Organization, 1995.

World Health Organization. *World Health Report 2002: Reducing Risks, Promoting Healthy Life*. Geneva, Switzerland: World Health Organization, 2002.

World Health Organization. *Core Health Indicators*. WHO Statistical Information System. World Health Organization, 2007

World Health Organization. *World Health Statistics 2010*. Geneva, Switzerland: World Health

Organization, 2010.

World Neighbors. World Neighbors Strategic Plan: Andean Region 2009-2011. World Neighbors, 2008.

3. An infant and young child feeding index is associated with child height-for-age and dietary adequacy in the Bolivian Andes

3.1 Introduction

Breastfeeding and complementary feeding practices are underlying determinants of child development and nutrition (UNICEF, 1990; Brown et al, 1998). Though accepted indicators to assess breastfeeding practices have been in common use for nearly two decades (WHO, 1991), developing simple measures to assess complementary feeding practices has been more elusive. Child feeding is a complex concept that encompasses multiple dimensions including the diversity of the diet, the texture and nutrient density of complementary foods, the maintenance of exclusive and partial breastfeeding, and the manner and frequency with which foods are fed (Dewey, 2003). Appropriate child feeding practices also change over time. As children get older they adapt to different food textures and require more frequent meals and a larger variety of foods.

In 2008, the World Health Organization published a new series of indicators for assessing infant and young child feeding (IYCF) practices (WHO, 2008). These indicators are designed for use in large-scale surveys and national programs, and with one exception, look at individual child feeding practices. One previous tool used to assess IYCF practices, a child feeding index, derives scores for five different indicators of child feeding practices and combines these scores into a single, composite index. Many programs that successfully improve complementary feeding of infants and young children take a comprehensive approach, promoting an age-specific package

of appropriate feeding practices adapted to local contexts (Caulfield et al, 1999). These programs simultaneously address several dimensions of child feeding by, for example, developing new recipes with mothers that are more nutrient dense and that include a larger diversity of ingredients. A child feeding index captures these multiple dimensions of child feeding into a single, age-specific index that allows for the assessment of feeding practices as a whole (Ruel and Menon, 2002). If positive child nutrition outcomes are associated with some minimum number of proper child feeding and care practices, a summary index would be more likely to detect these associations than would a measure of any single practice (Arimond and Ruel, 2001).

Several authors have used variations of a composite infant and child feeding index (ICFI) in different settings to explore associations between the index and child growth (see **Table 2**). Results from these studies are mixed, but generally show that in multivariate analyses controlling for various child, maternal and household level variables, the ICFI is positively associated with child height-for-age Z-score (HAZ) when using large data sets (i.e. $n \sim 1000$) from rural populations. The adjusted effect sizes reported in these studies ranged from 0.26 to 0.55 HAZ (“effect size” here refers to the difference in the average HAZ of children of mothers in the lowest tercile of the ICFI compared to mothers in the highest tercile of the ICFI). This range of effect sizes is analogous to that found in successful nutrition interventions (Brown et al, 1998; Penny et al, 2005) and is considered to be biologically meaningful (Martorell and Scrimshaw, 1995). The lack of a relationship found between the ICFI and child growth in some studies is hypothesized to be driven by a number of factors including 1) the negative association

between continued breastfeeding and child HAZ found particularly in urban areas (Arimond and Ruel, 2002; Moursi et al, 2009), 2) the importance of maternal characteristics in determining child nutrition outcomes, again, especially in urban settings (Srivastava and Sandhu, 2007), and 3) the inclusion of children older than three years of age in the index (Ntab et al, 2005). Only studies examining the relationship between *composite* child feeding indices and child growth are considered in **Table 2**. Numerous authors have developed specific dietary diversity scores and indices (Hatløy et al, 2000; Ruel, 2003; Arimond and Ruel, 2004; Alvarado et al, 2005; Savy et al, 2005; Steyn et al, 2006; Daniels et al, 2009), while others have used composite child feeding indices without reporting relationships between the indices and child growth (Armar-Klemesu et al, 2000; Sawadogo et al, 2008; Saha et al, 2008a). Two additional studies constructed composite child feeding and care indices and found that 1) more appropriate infant feeding practices were significantly positively associated with gain in weight and length during 1-12 months of age (Saha et al, 2008b), and 2) among children aged 0-23 months, length-for-age Z-score (LAZ) was positively correlated with access to appropriate feeding and care practices (Blaney et al, 2009). These studies were excluded from the summary in **Table 2** because their analytical methods were not amenable to comparison with other studies.

The present study examines the relationship between a composite ICFI and child nutritional status in the context of a small-scale, community-based program in rural Bolivia. Analyses are constructed using two different data sets, one collected in 2009 and the second in 2010, from an agriculture-centered nutrition education and growth monitoring program that recruited children from birth to 36 months of age. For each data set, the study aims to determine 1) the

relationship of the composite ICFI and its components to child HAZ, 2) the association between two measures of dietary adequacy and the ICFI, and 3) the relationship of select WHO IYCF indicators, in particular the “minimum acceptable diet” summary indicator, to child growth and dietary adequacy. Two data sets are employed, not to compare changes in feeding practices over time, but to explore at a cross-section how and why the ICFI and child growth and dietary adequacy are related in samples with distinctly different age compositions. Associations between the WHO summary indicator and child growth and dietary adequacy are considered here to compare the results of using these different tools (i.e. the ICFI and the WHO indicators) for measuring IYCF practices.

3.2 Subjects & Methods

Data collection & sampling

A baseline survey of 331 households with children aged approximately 0-24 months was conducted in 44 communities in March 2009. Four teams of enumerators administered the survey to mothers and heads of household using quantitative questionnaires programmed into hand-held computers (ASUS MyPal A696) for direct data capture. The use of these computers helped to minimize data entry error (Byass et al, 2008) and allowed for immediate data access during nightly data cleaning and review sessions with survey teams. Quantitative 24-hour dietary recalls specific to infants and young children in the household were administered to mothers using standardized household measures (Berti et al, 2010). Data on the type, preparation method, amount and consistency of foods fed to children as well as the amount

left unconsumed by children were collected to estimate children's dietary intakes on the day preceding interviews. An endline survey of 390 households with children aged 0-36 months was conducted one year later in March 2010. This survey was conducted in the same manner as the March 2009 survey and in the same 44 communities. The child age eligibility criterion was modified in the endline survey, however, to ensure families participating in the baseline survey were included in the follow up and to capture data on the new cohort of children born since the March 2009 survey.

Community census data were collected from local health posts responsible for sub-sectors within municipalities. These data were then confirmed by speaking with local authorities in each community. Communities with five or more households with children ≤ 24 months of age were purposefully selected at baseline from five previously-studied agroecological zones (Berti et al, 2010). These zones are differentiated by variations in elevation, crops and animals raised, average temperature, precipitation and topography. All families with children ≤ 24 months of age and ≤ 36 months of age at baseline and endline, respectively, were invited to participate in the study. Communities were visited by survey enumerators on multiple days to ensure all eligible families were offered the opportunity to participate in the study. Ninety-one percent of eligible families participated at baseline and 96% participated at endline. Nearly two-thirds of those families that did not participate at either baseline or endline were engaged in temporary wage or reciprocatory labor outside of their communities and were not available for interviews. Only three families in total from both survey rounds who were present at the time of the survey

declined participation. However, during the endline survey, authorities from two of the 44 survey communities, despite objections from families in those communities who wanted to participate, exempted their communities from participation because of internal political conflicts.

Infant and child feeding index

The ICFI was constructed as previously reported (Arimond and Ruel, 2002; Moursi et al, 2008) (see **Table 3**), however, the food groups for the 24-hour dietary diversity and 7-day food frequency components of the index were modified to reflect the food groupings of the new indicators for minimum dietary diversity (WHO, 2008)¹². Age-specific index score cut-offs based on distributions of 24-hour dietary diversity and 7-day food frequency consumption data for both 2009 and 2010 data sets closely reflected those previously reported (Arimond and Ruel, 2002). These age-specific index score cut-offs were used to calculate diet diversity and food frequency scores. Dietary diversity was calculated using data from infant and child 24-hour dietary recalls and from quantitative questionnaire data (to calculate the 7-day food frequency scores). Current indicators define minimum meal frequency (i.e. the number of times daily infants and young children should receive solid, semi-solid, or soft foods) as two times per day for breastfed infants 6-8 months and three times per day for breastfed children 9-23 months

¹²For the 24-hour dietary diversity component, cereal grains and tubers were combined into one “staple foods” category, the “milk” category was expanded to include all dairy products (breastmilk was not included), “animal protein foods” included only flesh foods, the “legumes” category was expanded to include nuts, the “fats” category was eliminated, and an “eggs” category was added. For the 7-day food frequency component, cereal grains and tubers had already been combined into a “staple foods” category in the original index. All other changes to the calculation of this scale component were the same as described above for the 24-hour dietary diversity component.

Table 2. Studies assessing the relationship between child feeding indices and child growth.

Site and reference	Sample size and data source ¹	Index characteristics ²	Association with child growth ³	Effect size ⁴ [child stunting]
Ghana Ruel et al, 1999	475 (urban) IFPRI urban study data (1997)	index range: -11 to 2 points 4-8, 9-17, 18-36 mo PF, BF, various foods given 0-4 mo, first food offered, feeding assistance, responsive feeding	+ HAZ 4-36 mo interactions: SES, maternal education	0.55 HAZ (all ages, only mothers with no education) [-0.93, 17%] (all ages)
Latin America (5 countries) Ruel and Menon, 2002	6347 (rural/urban) DHS data (1994-1999)	12-point scale 6-8, 9-11, 12-36 mo BF, BU, 24hr DD (6), 7d FF (3), MF	+ HAZ 12-36 mo interactions: SES, ethnicity, maternal education	0.5 HAZ (12-36 mo) [N/A, 12.3-42.1%] (all ages)
Ethiopia Arimond and Ruel, 2002	4624 (rural/urban) Ethiopia DHS data (2000)	9-point scale 6-8, 9-11, 12-36 mo BF, BU, 24hr DD (8), 7d FF (7), MF	+ HAZ 12-36 mo (rural) ø HAZ 12-36 mo (urban)	0.35 HAZ (12-36 mo) [N/A, 46%] (<3 yrs, rural)
Senegal Ntab et al, 2005	543 (rural) Data nested in IPTc Study (2003)	12-point scale 12-42 mo BF, BU, 24hr DD (6), 7d FF (3), MF	ø HAZ 12-42 mo	-0.19 HAZ (12-42 mo, unadj) [-1.02, N/A] (all ages)
China Lai et al, 2005	4127 (rural/urban) national nutrition survey (2002)	13-point scale 6-8, 9-11, 12-24 mo BF, 1 mo DD (6)	(unadjusted results) + HAZ all ages + WAZ 9-12, 12-24 mo	0.46 HAZ: ~lowest tercile to ~highest two terciles (all ages, unadj) [-0.82, N/A] (12-24 mo)
Burkina Faso Sawadogo et al, 2006	2466 (rural) cross-sectional study (Gnagna province) (2002)	9-point scale 6-11, 12-23, 24-35 BF, BU, MF, feeding snacks, FVS (8), DDS (8)	+ HAZ 6-11, 12-23 mo - HAZ 24-35 mo + WHZ 12-23 mo - WHZ 6-11 mo	0.43 HAZ (12-23 mo) [N/A, 52%] (all ages)
Côte d'Ivoire Becquet et al, 2006	557 (urban) Ditrame Plus study (2001-2003)	12-point scale 6, 9, 12, 18 mo milk source, 24hr DD (4), 7d FF (4), MF	(unadjusted results) low vs. avg or high ICFI tercile at 6 mo associated with lower HAZ at 12 and 18 mo	0.34 HAZ: low to avg or high terciles (at 12 mo, unadj) [-0.76 to -1.11 depending on ICFI tercile] (at 12 mo)
India Srivastava and Sandhu, 2007	204 (urban) cross-sectional survey (year of data collection not reported)	index scale not reported age groupings not reported BF, 24hr DD (foods not reported), MF, psychosocial care, hygiene during preparation and feeding	ø HAZ 6-23 mo ø WAZ 6-23 mo	effect size not reported [N/A, 50.5%] (all ages)
Madagascar Moursi et al, 2008	363 (urban) Nutrimad project data (2004)	9-point scale 6-8, 9-11, 12-17 mo BF, BU, 24hr DD (7), 7d FF (7), MF	ø LAZ all ages (cross-sectional ICFI) + LAZ all ages (longitudinal ICFI) ø WLZ all ages	0.5 LAZ (all ages, longitudinal ICFI) [-2.18, 58%] (12-17 mo)
Madagascar Moursi et al, 2009	1589 (urban) Nutrimad project data (2004)	9-point scale 6-8, 9-11, 12-23 mo BF, BU, 24hr DD (7), 7d FF (7), MF	ø HAZ 12-23 mo	0.1 HAZ (12-23 mo) [N/A, 47%] (all ages)
China Zhang et al, 2009	501 (rural) cross-sectional survey (2006-2008)	15-point scale 6-8, 9-11 mo BF, BU, 24hr DD (6), 24hr	ø LAZ all ages + WAZ all ages + WLZ all ages	0.15 WAZ (all ages) [0.01, 3.2%] (all ages)

	2007)	frequency of staple consumption, 7d FF (3), MF		
China Wang et al, 2009	3419 (rural) national nutrition survey (2005)	14-point scale 6-8, 9-11, 12-23 BF, BU, 24hr DD (6), 7d FF (4), MF	+ HAZ all ages + WAZ all ages	0.26 HAZ (all ages) [-0.56, 13.8%] (all ages)
India Garg and Chadha, 2009	151 (rural) cross-sectional survey (year of data collection not reported)	index range: 3-23 points 6-12 mo BF, BU, 24hr DD (7), initiation of CF, 7d FF (7), MF	+ LAZ all ages ø WAZ all ages	effect size not reported [N/A, 24.5%] (all ages)

Abbreviations: DHS, Demographic and Health Surveys; IPTc Study, Intermittent Preventive malaria Treatment in children Study; BF, breastfeeding; BU, bottle use; 24hr DD, 24-hour diet diversity; 7d FF, 7-day food frequency; 1 mo DD, 1-month diet diversity; MF, meal frequency; FVS, food variety score; DDS, diet diversity score; CF, complementary feeding; HAZ, height-for-age Z-score; LAZ, length-for-age Z-score; WAZ, weight-for-age Z-score. Individual authors' uses of HAZ or LAZ are reported in the table, however, it is assumed that the *lengths* of children aged <24 months was measured and the *heights* of children aged >24 months was measured.

¹"Sample size" refers to the largest sample size available (for all age groups combined) for analyses using the ICFI.

²This category includes: the number of points upon which the index is based, the age groupings used in the index, and the components of the scale; the number in parentheses after "DD" (diet diversity) represents the number of food groups considered in the diet diversity score calculation.

³All results are from adjusted analyses (i.e. those models controlling for various child, maternal and household level variables) unless otherwise stated; "+ HAZ 12-36 mo" means that after adjusting for potential confounding variables in a multivariate analysis, a significant positive association was found between the feeding index and child height-for-age Z-score among children 12-36 months of age; "ø LAZ all ages" means that no significant association was found between the feeding index and child length-for-age Z-score among all children combined in the study; "Interactions" are those significant interactions between ICFI terciles and the given variable.

⁴Effect size refers to the adjusted magnitude of difference between the lowest and highest ICFI terciles for the given age range of children unless otherwise stated (for example, a difference of 0.5 HAZ from low to high terciles means that the mean HAZ of children in the highest feeding tercile was 0.5 Z-scores higher than the mean HAZ of children in the lowest feeding tercile). The information in brackets refers to the mean HAZ for the population and the percent of children stunted (<-2 HAZ), respectively.

(WHO, 2008). The meal frequency scoring criterion of the current ICFI closely reflects that of these new indicators so no changes to the scoring scale were made¹³. Current recommendations to practice exclusive breastfeeding up to six months of age and continue breastfeeding to at least two years of age have not changed (WHO, 2001); therefore, the breastfeeding and bottlefeeding components of the original ICFI were also left unchanged.

Table 3. Infant and child feeding index.

Variables	6-8 mo	9-11 mo	12-36 mo
Breastfeeding	No=0 Yes=2	No=0 Yes=2	No=0 Yes=1
Bottle use	No=1 Yes=0	No=1 Yes=0	No=1 Yes=0
Dietary diversity (24h)¹	0 foods/groups=0 1-2 foods/group=1 3+ foods/groups=2	0 foods/groups=0 1-2 foods/groups=1 3+ foods/groups=2	0-1 foods/groups=0 2-3 foods/groups=1 4+ foods/groups=2
Food frequency (7d)²	sum of 0-1=0 sum of 2-3=1 sum of 4+=2	sum of 0-2=0 sum of 3-5=1 sum of 6+=2	sum of 0-3=0 sum of 4-6=1 sum of 7+=2
Frequency of feeding solids/semisolids (24h)	Not at all=0 Once=1 2+ times=2	Not at all=0 1-2 times=1 3+ times=2	0-1 times=0 2 times=1 3 times=2 4+ times=3
Minimum/maximum	0/9	0/9	0/9

Cut-offs shown for the 24-hour dietary diversity and 7-day food frequency consumption components are derived from distributions from the 2009 data set.

¹Sum of: cereal grains, roots, tubers + legumes and nuts + dairy products (milk, yogurt, cheese) + flesh foods (meat, fish, poultry and liver/organ meats) + eggs + vitamin-A rich fruits and vegetables + other fruits and vegetables (received or did not receive each food/group).

²Each food group is scored as 0 if not given at all in the previous 7 days, 1 if given on 1-3 days, and 2 if given on 4 or more days. These scores are then summed to give a possible range of 0 to 14.

¹³Infants 6-8 months receive two points for receiving solid, semi-solid, or soft foods at least two times in the previous 24 hours (and fewer or zero points for a lower meal frequency), while children 9-23 months receive two or more points for receiving these foods at least three times in the previous 24 hours (and fewer or zero points for a lower meal frequency).

The guiding principles for complementary feeding of breastfed children provide recommendations only for children younger than 24 months of age (Dewey, 2003). The ICFI in this study, however, includes children aged 24-36 months for three reasons: 1) to emphasize the vulnerability of children in this age range and their continued need to receive appropriate complementary foods (Arimond and Ruel, 2002), 2) to facilitate comparisons with previous indices and 3) to utilize available data. Feeding recommendations for children older than 24 months are based upon available scientific evidence (Brown et al, 1998).

The raw, continuous ICFI score (0-9) was used in all analyses, however, this score was also divided into age-specific feeding terciles. Though creating terciles from the ICFI score is an arbitrary division of the data and results in loss of information, analyses using these ICFI score categories were conducted to facilitate comparisons with previous authors' analyses using ICFI tercile groupings.

Dietary adequacy

Child energy and nutrient intakes were estimated using 24-hour recall data combined with data from a Bolivian food composition table (Ministerio de Salud y Deportes, Gobierno de Bolivia, 2005). The micronutrient adequacy of child diets was assessed using nutrient densities (amount per unit energy of complementary food) as previously described (Dewey et al, 2005; Moursi et al, 2009). Individual nutrient densities were calculated as the nutrient intake divided by the child's total energy intake (MJ) in the previous 24 hours. This amount was then divided by the recommended nutrient density calculated by dividing the Recommended Dietary Allowance

(RDA) for the nutrient (Institute of Medicine, 2006) (i.e. the Estimated Average Requirement plus 2 standard deviations) by the child's age-specific energy requirement from complementary foods assuming an "average" breastmilk intake (Brown et al, 1998). The RDA was adjusted by subtracting out the amount of the given nutrient consumed from an "average" intake of breastmilk to provide an estimate of the RDA from complementary foods only. When RDA data were not available, adequate intakes (AI) were used.

Estimates of recommended energy requirements for infants and children aged 6-24 months were based on data from developing countries that accounted for breastmilk intake (Brown et al, 1998). These data were not available for children older than 2 years of age. Therefore, dietary reference intake (DRI) equations (Institute of Medicine, 2006) were used to calculate estimated energy requirements (EER) for children aged 24-36 months. Because negligible breastmilk intakes were assumed for these calculations, the EER for children still receiving breastmilk beyond 2 years of age may overestimate the actual EER from complementary foods.

The Bolivian Food Composition Table was incomplete for zinc and folate; food composition data for these two micronutrients were imputed from the Peruvian Food Composition Table (Centro Nacional de Alimentación y Nutrición Perú, 2009) and where not available from the Peruvian data, the USDA National Nutrient Database for Standard Reference (U.S. Department of Agriculture, 2010). In total, the individual micronutrient density adequacy scores of nine key micronutrients (thiamin, riboflavin, niacin, folate, vitamin C, vitamin A, iron, zinc, and calcium) were averaged and capped at 100% to create a mean micronutrient density adequacy (MMDA)

score for each child.

Anthropometry

Child heights and lengths were measured by survey enumerators trained in anthropometry using locally-manufactured replicas of child measuring boards (Shorr productions, Olney, MD, USA) and child weight data were collected using Seca spring scales (Seca Medical Scales and Measuring Systems, Hamburg, Germany) calibrated daily using standardized weights and recalibrated between individual weighings. Intra- and inter-anthropometrist error in measuring child length were assessed during anthropometry reliability trials (Cogill, 2003) prior to both survey rounds. Mean intra-observer measurement imprecision for child length for the four survey teams, expressed as the technical error of measurement (TEM), was 0.19 and 0.29 in 2009 and 2010, respectively. Mean inter-observer TEM was 0.33 in 2009 and 0.42 in 2010. These figures are within the upper limits of total TEM for a high level of reliability (Ulijaszek, 1998). Anthropometric indices (i.e. height-for-age, weight-for-age, and weight-for-height Z-scores) were calculated in SAS using macros provided by the World Health Organization based on data from the Multicentre Growth Reference Study (WHO, 2006).

Other variables

An index of household socioeconomic status (SES) was generated using a principal components analysis (PCA). Thirteen continuous variables, selected *a priori* based on formative research with communities about wealth indicators, were transformed to approach normally distributed variables and then standardized to account for differences in unit scales. Measures of land

ownership, animal ownership, community elevation, agricultural production and household size were included. Discrete variables were excluded from analyses to avoid violating important assumptions of PCA (Kolenikov and Angeles, 2004). Factors with eigenvalues ≥ 1 were first rotated using a varimax rotation and then divided into tercile groupings for inclusion in statistical models as three-level discrete variables. Analyses using baseline data included two extracted factors and those analyses using endline data included three factors.

Four of the new WHO IYCF indicators were included in analyses: 1) indicator 3, continued breastfeeding at one year (for children 12-15 months), 2) indicator 5, minimum dietary diversity (for children aged 6-23 months), 3) indicator 6, minimum meal frequency (for children aged 6-8 months and 9-23 months), and 4) indicator 7, minimum acceptable diet (for children aged 6-23 months). Indicator 7 is the only summary measure included in the new indicators, that is, it is the only indicator attempting to capture more than one dimension of child feeding in a single indicator.

Statistical analysis

Bivariate associations between the ICFI and its components and child HAZ were conducted using ANOVA. All multivariate analyses were conducted using a mixed-effects model (the PROC MIXED procedure in SAS) that accounted for the nested design effect of the study (i.e. households within communities and communities within treatment groups; households and communities were entered into models as random effects). The Kenward-Roger method was used to adjust for unbalanced data. Adjusted analyses controlled for child age, child sex, child

health status, maternal age and education level, and household socioeconomic status (including household size, land and animal ownership, agricultural production and community elevation). All relationships were examined separately using baseline and endline data for all age groups combined and for children aged 12-36 months. Two-way interaction terms between the ICFI and all potential confounders were tested in all models. All significant interaction terms were included in the final models along with the main effects of every potential confounding variable. Standard assumptions of homoscedasticity and normality of errors were tested for all models and found not to be violated.

All statistical analyses were performed using SAS (version 9.1, SAS Institute, Cary, NC). Associations were considered significant at $p < 0.05$ and reported as marginally significant at $p < 0.1$.

Ethics

The study protocol was approved by the Cornell University Institutional Review Board for Human Participants. All individuals surveyed gave informed oral consent to participate in the study. Families received a 0.45 L bottle of vitamin A-fortified vegetable oil for each child weighed and measured as compensation for their participation.

3.3 Results

Sample characteristics

Of the 331 families in the baseline survey, 6 families had more than one child less than 24 months of age. One observation was excluded because of unreliable birthdate data and 73 observations were excluded from ICFI analyses because the children were younger than six months of age. Data for children older than 24 months of age (maximum of 26 months) were collected from 18 families and included in the baseline sample. Therefore, baseline data from 263 children were included in final ICFI analyses combining children of all age groups. Of the 390 families surveyed in 2010, 46 families had more than one child ≤ 36 months. Data from 64 children aged less than six months and 11 children older than 36 months were excluded from final ICFI analyses. In total, endline data from 361 children were included in the final ICFI analyses combining children of all age groups. Children aged 24-36 months accounted for 36% of this final sample.

The overall prevalence of stunting (LAZ or HAZ < -2 Z-scores) among all children was 50.1% in 2009 and 54.6% in 2010. Mean LAZ/HAZ were -2.07 and -2.16 at baseline and endline, respectively. Prevalence of underweight (weight-for-age Z-score (WAZ) < -2 Z-scores) in 2009 was 14.8% with a mean WAZ of -1.09 and in 2010 15.2% of children were underweight with a mean WAZ of -0.97. Very few children were wasted (weight-for-height Z-score < -2 Z-scores) in either sample: 1.9% in 2009 and 2.5% in 2010. Mothers on average were 30.9 ± 7.6 years old with a range of ages from 16 to 50. Slightly more than 95% of these women either never attended school or never finished primary school. They had on average 3.5 ± 1.9 children with a

range from 1 to 10 (data on mothers and household size are from 2010 sample; 2009 data are similar but not reported). Fifty-two percent of mothers surveyed in 2010 reported losing a child before they reached their fifth birthday and nearly half of these women reported the death of more than one preschool-aged child. At baseline 58.2% of mothers reported that their child had experienced diarrhea symptoms in the past two weeks while more than a third reported their children having these symptoms at endline in 2010 (38.0%).

Child feeding practices

In both samples, breastfeeding is practiced by nearly all mothers through the first year of life. At baseline, mothers reported exclusively breastfeeding (i.e. feeding the child only breastmilk, ORS, vitamins, minerals, or medicines) for 3.4 ± 1.9 months and discontinuing any breastfeeding at 15.8 ± 4.8 months. Only 17.9% of mothers reported feeding exclusively breastmilk for the first six months of life. The use of feeding bottles declined after 12 months of age; however, 20.6% and 13.6% of mothers with children one year or older at baseline and endline, respectively, still reported having fed their child with a bottle in the previous day.

The percentage of mothers scoring the maximum amount of points for dietary diversity on the ICFI (i.e. 2 points for both 24h and 7d diversity components) declined at both baseline and endline ($p < 0.01$) as the age of the child increased (see **Table 4**). This suggests that as children aged, the diversity of their diets did not increase sufficiently to meet recommended requirements. However, the mean number of food groups older children received in the previous 24 hours was significantly higher than that of infants at baseline ($p < 0.001$) and at

endline ($p<0.1$) (see **Table 5**). The diets of less than one third of children aged 6-23 months at baseline (29.4%) met the WHO indicator standard for minimum dietary diversity.

The mean number of times older children were fed solid or semisolid foods in the previous 24 hours was greater than the number of times infants were fed these foods at both baseline and endline ($p<0.01$) (see **Table 5**). Similar to diet diversity however, a smaller percentage of mothers with older children at both baseline and endline ($p<0.001$) scored the maximum amount of points for meal frequency on the ICFI as compared to mothers with infants. At baseline, a higher proportion ($p<0.001$) of younger infants (6-8 mo) met the standard for minimum meal frequency according to the WHO indicator as compared to older infants and young children (9-23 mo). At endline, there was no difference with more than half of all children in both age groups meeting the minimum meal frequency standard.

Association between ICFI and child nutritional status

In bivariate analyses, the continuous ICFI score and child HAZ for all ages combined were strongly associated ($p<0.001$) at both baseline and endline. These associations were likewise significant for children aged 12-36 months at baseline ($p<0.05$) and marginally significant at endline ($p<0.1$). After dividing the continuous ICFI into age-specific terciles, the association between the tercile groupings and child HAZ for all ages combined was significant at baseline ($p<0.0001$) and endline ($p<0.01$). Examining only data for children aged 12-36 months, this relationship was only marginally significant ($p<0.1$). Among these older children, a difference in mean HAZ of 0.36 and 0.34 was found between the lowest and highest terciles at baseline and

endline, respectively.

After adjusting for potential confounding variables, the positive relationship between child HAZ and the raw ICFI score for all ages combined remained at both baseline and endline ($p < 0.05$). This relationship was also observed at baseline for children aged 12-36 months ($p = 0.05$), but not at endline. A one unit increase in the continuous ICFI score for children aged 12-36 months translated into a 0.13 and 0.04 Z-score increase in child HAZ at baseline and endline, respectively. Adjusted mean child height-for-age Z-scores for all ages combined were associated with ICFI terciles at baseline ($p = 0.01$) (a significant interaction with household socioeconomic status was found) and marginally associated at endline ($p = 0.07$) (see **Figure 3**). ICFI terciles were also marginally positively associated with mean child HAZ either for children aged 12-36 months at baseline ($p = 0.1$) and interacted with household SES at endline ($p = 0.01$) (see **Figure 4**). The adjusted mean HAZ of children aged 12-36 months in the highest feeding tercile was 0.44 HAZ and 0.23 HAZ greater than that of children in the lowest feeding tercile at baseline and endline, respectively.

Table 4. Percentage of mothers reporting selected feeding practices by child age group and indicator type (i.e. feeding index components and World Health Organization indicators).

INFANT AND CHILD FEEDING INDEX (ICFI)								
		2009				2010		
<i>child age (mo)</i>		6-8	9-11	12-26		6-8	9-11	12-36
<i>n</i>		55	43	165		37	31	293
Mean ± SD		7.3 ± 1.3	6.9 ± 1.1	5.5 ± 1.3		7.0 ± 2.1	7.0 ± 1.4	5.8 ± 1.8
Median (range)		7 (3-9)	7 (4-9)	6 (2-9)		8 (1-9)	7 (3-9)	6 (1-9)
% still breastfeeding		98.2	97.7	77.6		97.3	100	59.7
% avoiding bottle use		67.3	74.4	79.4		75.7	71.0	86.4
24h dietary diversity score (% per index score level)	0	3.64	2.3	11.5		21.6	9.7	13.3
	1	36.4	46.5	54.6		5.4	19.4	43.3
	2	60.0	51.2	33.9		73.0	71.0	43.3
7d food frequency score (% per index score level)	0	9.1	0	11.5		16.2	6.5	15.7
	1	36.4	46.5	50.9		16.2	51.6	53.2
	2	54.6	53.5	37.6		67.6	41.9	31.1
meal frequency score (% per index score level)	0	7.3	2.3	10.9		27.0	12.9	15.4
	1	21.8	76.7	45.5		21.6	41.9	22.5
	2	70.9	20.9	32.7		51.4	45.2	23.2
	3	N/A	N/A	10.9		N/A	N/A	38.91
WHO IYCF INDICATORS								
		2009				2010		
	<i>child age (mo)</i>	<i>n</i>	%			<i>n</i>	%	
% practicing continued breastfeeding at 1 year	12-15	24	100.0			34	100.0	
% meeting minimum dietary diversity	6-23	245	29.4			231	55.8	
% meeting minimum meal frequency	6-8	55	70.9			37	51.4	
	9-23	190	40.0			194	58.3	
% meeting minimum acceptable diet	6-23	245	13.5			231	33.3	

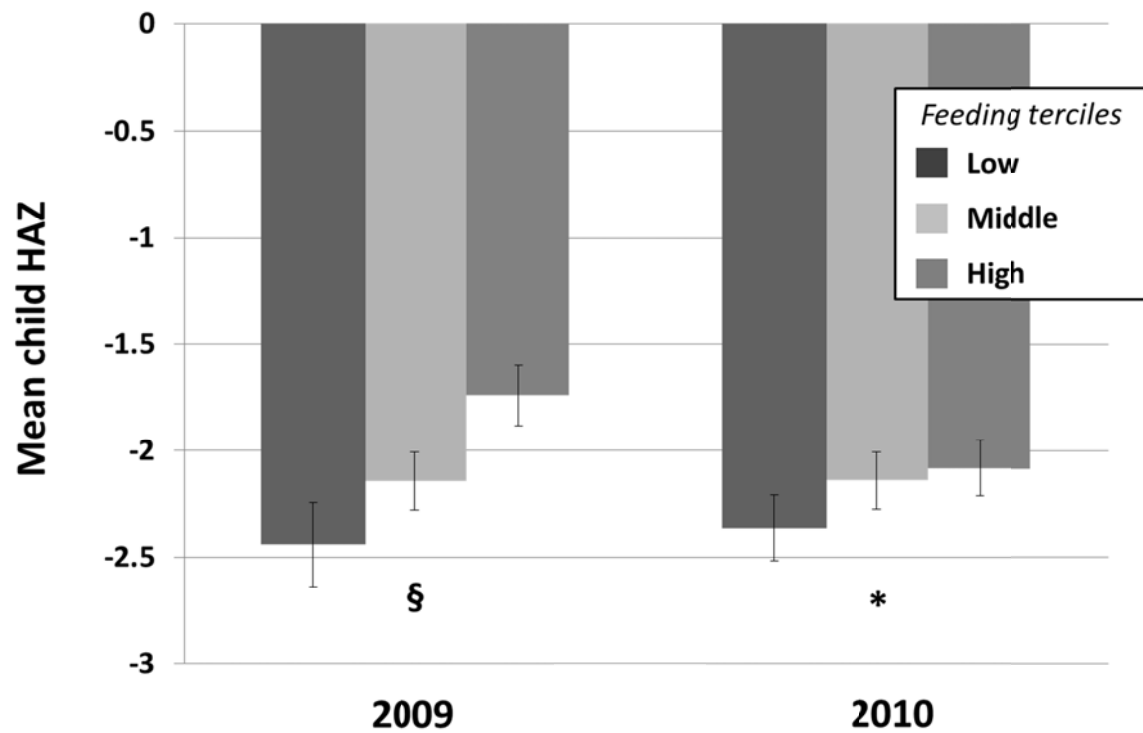
Table 5. Mean number of food groups fed and mean number of times solid or semisolid foods were fed in the previous 24 hours.

		2009				2010		
<i>child age (mo)</i>		6-8	9-11	12-26		6-8	9-11	12-36
<i>n</i>		55	43	165		37	31	293
mean (\pm SD) number of food groups fed (24h)		2.27 \pm 1.41	2.47 \pm 1.37	2.98 \pm 1.22		2.57 \pm 1.74	3.03 \pm 1.58	3.12 \pm 1.43
mean (\pm SD) number of times solids/semisolids fed (24h)		2.04 \pm 1.00	2.12 \pm 0.73	2.47 \pm 0.96		1.78 \pm 1.55	2.48 \pm 1.59	3.00 \pm 1.57

Results from multivariate analyses are shown in **Table 6**. The ICFI tercile variable interacted with household SES in both survey rounds. **Figure 5** shows those results for the endline survey round. The difference in mean child HAZ between the highest and lowest ICFI tercile groupings was significantly larger among families with less access to productive assets.

The new WHO “minimum acceptable diet” measure (indicator 7) was not related to child HAZ at either baseline or endline in bivariate or multivariate analyses. Continued breastfeeding at one year (indicator 3) and minimum dietary diversity (indicator 5) were similarly not related to child HAZ at any time point, however, in adjusted analyses, minimum meal frequency (indicator 6) was positively associated with child HAZ either as a main effect or as an interaction term in data from both 2009 and 2010.

Figure 3. Mean adjusted height-for-age Z-score by feeding index tercile (all ages).



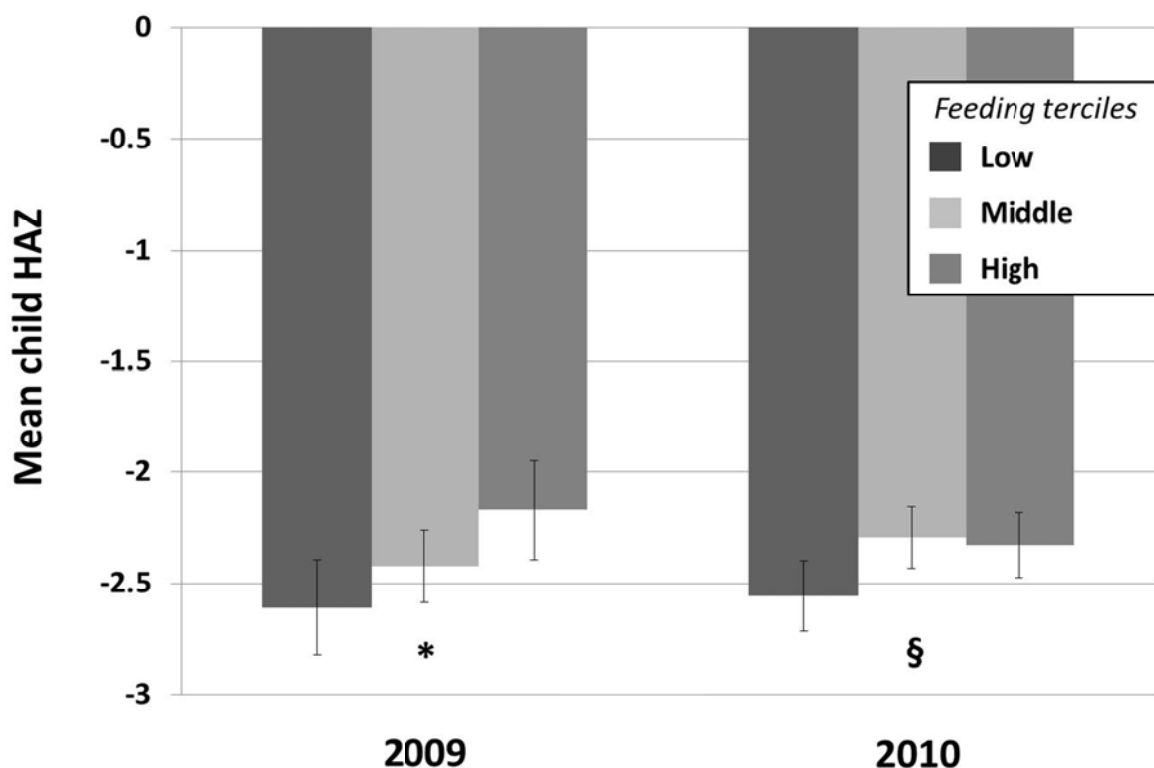
§ interaction with household SES: $p=0.01$

* $p=0.07$

Mean adjusted HAZ \pm SEM are shown for 2009 ($n=263$) and 2010 ($n=361$) data sets. Data are presented for all age groups combined. Mean HAZ are adjusted by child age, child sex, child health status, mother's age, mother's height, mother's education, household size and socioeconomic status. P-values are for differences in mean child HAZ between the highest and lowest feeding terciles.

Sample sizes by tercile are as follows: 2009 – "High" $n=105$; "Middle" $n=115$; "Low" $n=43$; 2010 – "High" $n=161$; "Middle" $n=123$; "Low" $n=77$.

Figure 4. Mean adjusted height-for-age Z-score by feeding index tercile (ages 12-36 months).



* p=0.1

§ interaction with household SES: p=0.01

Mean adjusted HAZ \pm SEM are shown for 2009 (n=165) and 2010 (n=293) data sets. Data are presented for children 12-36 months only. Mean HAZ are adjusted by child age, child sex, child health status, mother's age, mother's height, mother's education, household size and socioeconomic status. P-values are for differences in mean child HAZ between the highest and lowest feeding terciles.

Sample sizes by tercile are as follows: 2009 – “High” n=36; “Middle” n=89; “Low” n=40; 2010 – “High” n=111; “Middle” n=113; “Low” n=69.

Association between ICFI components and child nutritional status

Table 7 shows the relationships between individual components of the ICFI and adjusted mean child HAZ. Neither the 24-hour dietary diversity score nor the 7-day food frequency score were associated with child HAZ. The mean HAZ of children fed with feeding bottles in the previous 24

hours did not differ at any time from children fed without bottles. In the younger 2009 cohort, meal frequency strongly predicted mean HAZ. Children of mothers scoring highest on this component of the index had on average 0.91 HAZ greater than children of mothers with the lowest scores when analyzing all age groups combined. Continued breastfeeding showed a strong relationship with mean HAZ at endline with a difference in HAZ of 0.41 between children who were breastfed compared to fully weaned children.

Dietary adequacy

In adjusted analyses from both years, the ICFI tercile variable was associated with mean child energy intake either as a main effect or interaction term for all ages combined and for children aged 12-36 months of age. Children in the highest tercile grouping consumed more energy than children in the lowest tercile grouping (**Figure 6**). In the 2010 data for all children combined, child feeding practices interacted with child age: the difference in mean energy intake between the highest and lowest tercile groupings was greater for older children than for infants and younger children.

Similarly, child feeding practices were consistently associated with mean micronutrient density adequacy (MMDA) score for children aged 12-36 months (**Figure 7**) and for all ages combined. Children in the highest ICFI tercile grouping had higher MMDA scores than children in the lowest ICFI tercile grouping. In the 2010 data for children aged 12-36 months, a significant interaction between maternal age and child feeding practices revealed that the difference in MMDA scores between the highest and lowest ICFI tercile groupings of younger (<25 yrs) and

older (>35 yrs) mothers was greater than among women aged 25-35 yrs.

The WHO “minimum acceptable diet” indicator was also positively associated with both mean child energy intake and MMDA score in adjusted analyses from both data sets (**Figures 6 and 7**).

Table 6. Adjusted regression coefficients for determinants of child height-for-age Z-score .

	2009		2010	
<i>Child age (mo)</i>	All ages (6-26)	12-26	All ages (6-36)	12-36
<i>n</i>	263	165	361	293
High tercile: ICFI (low)	interaction	0.439 (p=0.1)	0.28 (p=0.07)	interaction
Mid tercile: ICFI (low)				
Child age in months	-0.039 (p<0.01)	-0.04 (p<0.1)	-0.031 (p<0.0001)	-0.025 (p<0.01)
Child sex (male)	0.412 (p<0.01)		0.596 (p<0.0001)	0.5174 (p<0.0001)
Child health (no diarrhea)	-0.254 (p<0.1)			-0.206 (p=0.1)
Maternal age in years	-0.017 (p<0.1)		-0.024 (p=0.01)	-0.03 (p<0.01)
Maternal height	0.023 (p<0.1)		0.025 (p=0.02)	0.019 (p=0.1)
Mother’s education level (none)				
High tercile: SES factor 1 (low)	interaction			interaction
Mid tercile: SES factor 1 (low)				
High tercile: SES factor 2 (low)				
Mid tercile: SES factor 2 (low)				
High tercile: SES factor 3 ¹ (low)	N/A	N/A		
Mid tercile: SES factor 3 ¹ (low)	N/A	N/A		
ICFI tercile*SES factor 1	p=0.01			p=0.01

P-values are <0.05 unless otherwise stated.

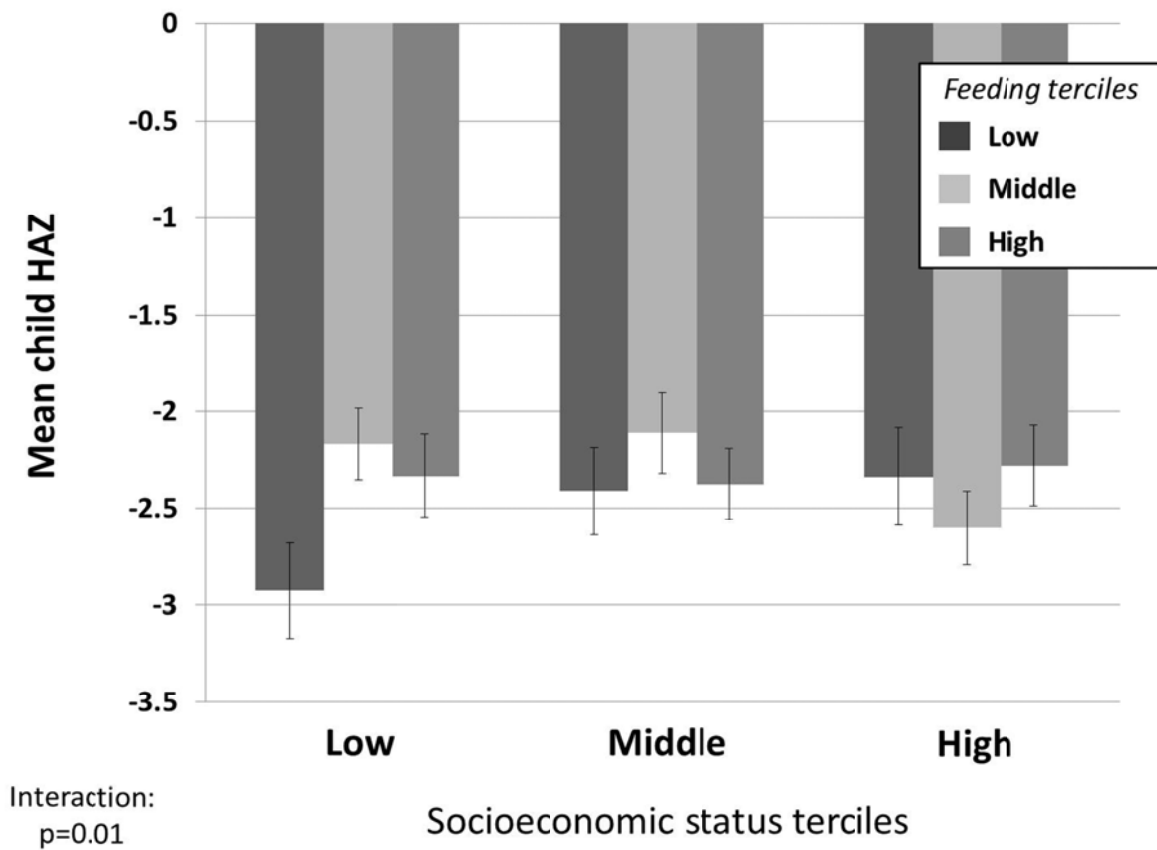
Blank cells indicate that no association was found between the variable and child HAZ.

Labels in parentheses next to categorical variable names signify the reference level used for that independent variable.

Where interaction terms were found to be significant, regression coefficients and p-values of main effects are omitted.

¹SES factor 3 only applies to 2010 data.

Figure 5. Mean adjusted child height-for-age Z-score by feeding index terciles for each level of socioeconomic status.



Mean adjusted HAZ \pm SEM are shown for the 2010 data set for children aged 12-36 months (n=293). This SES factor primarily explains variation in land ownership, and cereal grain and potato harvests between households.

Table 7. Associations between feeding index components and adjusted mean height-for-age Z-score.

	2009				2010			
<i>child age (mo)</i>	all ages (6-26 mo)		12-26 mo		all ages (6-36 mo)		12-36 mo	
<i>n</i>	263		165		361		293	
	p value	mean HAZ	p value	mean HAZ	p value	mean HAZ	p value	mean HAZ
Breastfeeding score ¹ (high)	0.44	-2.10	0.54	-2.48	0.03	-2.07	0.01	-2.22
Breastfeeding score (low)		-1.93		-2.34		-2.43		-2.63
Bottle not used in past 24hr	0.99	-2.08	0.92	-2.45	0.7	-2.18	0.41	-2.37
Bottle used in past 24hr		-2.07		-2.43		-2.24		-2.52
24h DD score (high)	0.48	-1.99	0.96	-2.40	0.18	-2.09	0.33	-2.33
24h DD score (low)		-2.18		-2.38		-2.33		-2.52
7d FF score (high)	0.20	-2.03	0.42	-2.43	0.15	-2.11	0.3	-2.37
7d FF score (low)		-2.36		-2.68		-2.37		-2.58
Meal frequency score ² (high)	0.0005	-1.87	0.02	-2.21	0.98	-2.21	0.42	-2.43
Meal frequency score (low)		-2.78		-2.89		-2.21		-2.29

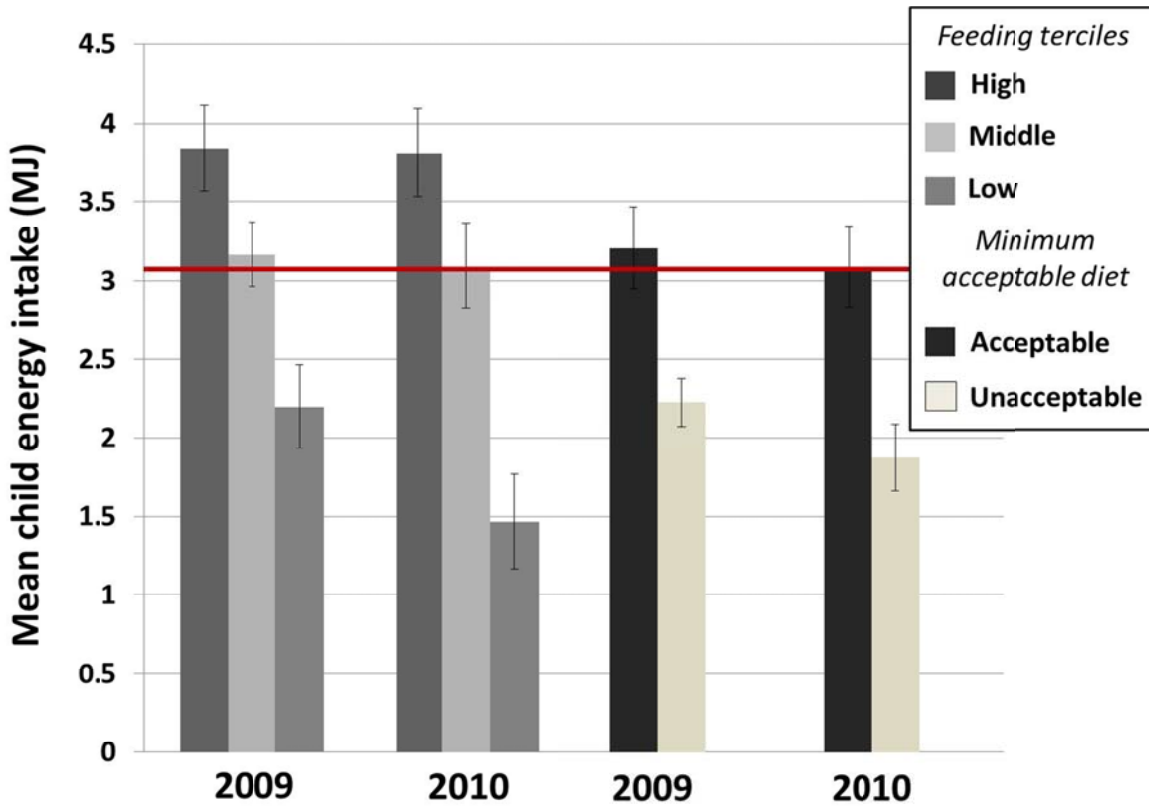
Abbreviations: 24h DD, 24-hour diet diversity; 7d FF, 7-day food frequency.

Means are adjusted for child age, child sex, child health status, maternal age, mother's height, mother's education, household size and socioeconomic status. P-values are for the differences in mean HAZ shown for each ICFI component.

¹Breastfeeding score was converted to a dichotomous variable as the score takes different values for different age groups (0 or 2 for children aged 6-8 and 9-11 months and 0 or 1 for children aged 12-36 months).

²Meal frequency scores range from 0-2 for children 6-8 and 9-11 months and 0-3 for children 12-36 months. For these analyses, scores of 2 and 3 were combined for children aged 12-36 months.

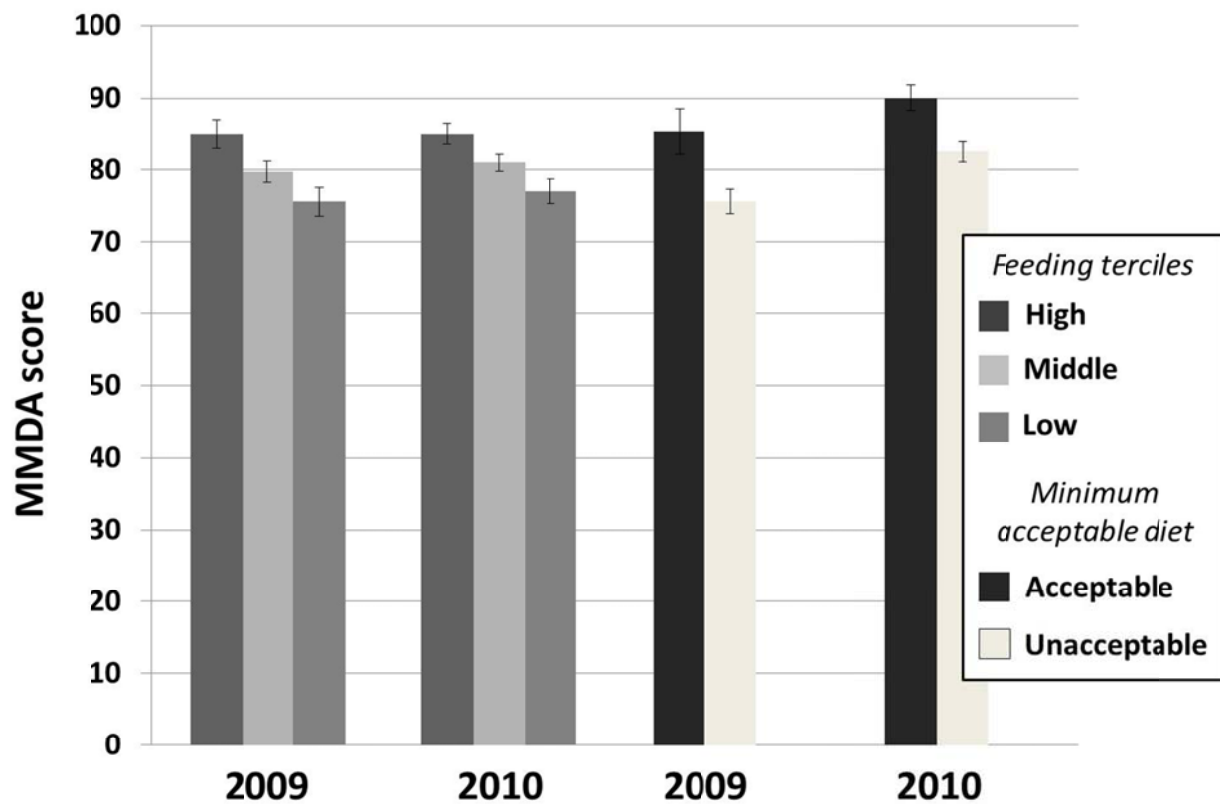
Figure 6. Adjusted mean child energy intake by child feeding practices.



all differences: $p < 0.0001$

Adjusted mean child energy intake (MJ) \pm SEM data are shown for children aged 12-36 months. Child feeding practices are indicated using the ICFI (as tertiles) and the WHO “minimum acceptable diet” indicator. The solid horizontal line indicates the recommended energy intake from complementary foods for children aged 12-23 months who receive an average amount of breastmilk (Brown et al, 1998). Sample sizes are as follows: for 2009 ICFI tertile data (n=165), for 2010 ICFI tertile data (n=293), for 2009 “minimum acceptable diet” data (n=245), and for 2010 “minimum acceptable diet” data (n=231).

Figure 7. Adjusted mean micronutrient density adequacy (MMDA) score by child feeding practices.



all main effects or interactions: $p < 0.05$

Adjusted mean micronutrient density adequacy (MMDA) score \pm SEM data are shown for children aged 12-36 months. Child feeding practices are indicated using the ICFI (as tertiles) and the WHO “minimum acceptable diet” indicator. Sample sizes are as follows: for 2009 ICFI tertile data ($n=161$), for 2010 ICFI tertile data ($n=273$), for 2009 “minimum acceptable diet” data ($n=240$), and for 2010 “minimum acceptable diet” data ($n=209$). Five children in 2009 and 31 children in 2010 were reported to consume zero energy in the previous 24 hours. These children were excluded from MMDA analyses to avoid division by zero.

3.4 Discussion

Key findings of ICFI relationships

After controlling for several potential confounding variables, infant and young child feeding practices as measured by an ICFI showed positive associations with mean child HAZ and dietary adequacy measures. Analyses conducted using the continuous ICFI score and data from all age groups combined showed the strongest relationships with mean child HAZ. Significance tests for these analyses drew upon the maximum amount of information available in each data set. However, after dividing the continuous score into terciles and focusing only on children aged 12-36 months, the ICFI terciles still demonstrated a positive association with mean child HAZ in both data sets, albeit only a marginal association at baseline ($p=0.1$). The difference in adjusted mean HAZ of children aged 12-36 months in the highest tercile grouping of the ICFI compared to the lowest grouping was large, biologically significant and comparable to effect sizes found in previous studies (0.44 HAZ at baseline and 0.23 at endline).

Differences in IYCF practices as measured by the ICFI were also associated with important differences in the adequacy of child diets. At baseline, children aged 12-36 months in the highest ICFI tercile consumed on average 70% more energy than children in the lowest tercile. This percent difference was more than 3 times that amount at endline. Children one year of age or older in the highest feeding tercile on average achieved the recommended energy intake from complementary foods (assuming an average breastmilk intake) at both baseline and endline, whereas children in the lowest feeding tercile fell short of this recommended amount. An additional measure of dietary adequacy, the MMDA score, was also on average higher for

children in the highest feeding tercile compared to children in the lowest feeding tercile.

The ICFI interacted with household SES status at both baseline and endline. The difference in mean child HAZ between the highest and lowest ICFI tercile groupings was significantly larger for mothers from poorer households suggesting that the returns from improved child feeding practices on child nutritional status are particularly significant for these families. These findings confirm similar findings from Colombia and Nicaragua (Ruel and Menon, 2002) and Ghana (Ruel et al, 1999). For nutrition programs working in isolated, resource-poor environments where delivering external food assistance and fortified complementary feeding products remains a challenge, this encouraging finding suggests improvements in breastfeeding and complementary feeding practices drawing upon existing community resources may be an effective initial approach to improving child nutrition for the poorest families.

Previous studies have observed interactions between maternal education and the ICFI. One such study found that improvements in feeding practices more profoundly translated to improvements in child nutritional status for women with less education (Ruel et al, 1999). Failure to observe such an interaction in this population is likely due to the extreme homogeneity in levels of maternal education across the sample. Only a small percentage of mothers in either data set (<5%) completed or received schooling beyond primary school.

Variation in ICFI relationships by data set

The age composition of the two data sets analyzed in this study differs considerably with only 7% of the baseline sample aged >24 months and more than a third aged <12 months. In the

endline sample, 36% of children are older than two years and fewer than 20% are under one year of age. The fact that mean child height-for-age Z-scores falter dramatically until approximately 24 months of age (Victora et al, 2010), a trend confirmed by the distribution of child height-for-age Z-scores by age in this population, may help to explain the higher prevalence of stunting and lower mean HAZ of children in the older 2010 sample.

Endline data were collected following an eight-month, agriculture-centered nutrition education intervention explicitly designed to improve IYCF practices in participating mothers. The evaluation results of this intervention are reported in **Chapter 5**. The purpose of presenting baseline and endline data here is not to compare changes in feeding practices over time, but to elucidate differences in ICFI relationships between the two, compositionally-different samples. The difference in adjusted mean HAZ for children aged 12-36 months in the highest versus the lowest ICFI terciles at baseline was much larger than that difference at endline. It has been suggested that the ICFI reflects not only current feeding practices, but also a collection of more persistent behaviors that mothers consistently practice (Moursi et al, 2008). This assumption may not hold for those mothers participating in the endline survey. Many of these mothers (38% of the sample) were exposed to intervention activities in the months preceding the survey and only recently adopted improved feeding practices. It is possible that insufficient time had passed for improvements in IYCF practices to translate into improvements in child linear growth. In addition, for those children already approaching two years of age at baseline, it is unlikely that improvements in feeding practices would measurably change their growth trajectory at such a late stage (Lutter et al, 1990; Martorell et al, 1994).

The number of meals (including snacks) consumed in the previous 24 hours showed the strongest relationship to child HAZ at baseline confirming similar relationships found in previous studies (Arimond and Ruel, 2002; Sawadogo et al, 2006; Wang et al, 2009). Indeed, in sub-analyses (data not shown), dietary energy intake for all children combined and for children aged 12-36 months was positively associated with child nutritional status at baseline, but not endline. For children in the younger baseline cohort, the frequency of feeding, which is reflected in dietary energy intake, is an important predictor of child nutritional status. Women in northern Potosí bear numerous responsibilities both in the home and on the farm that limit the amount of time they can dedicate to child feeding. In this population, finding ways to allow mothers to incorporate more frequent feeds into their daily routines may compensate for some of the deficiencies in dietary diversity observed in this region and be particularly beneficial for partially weaned children (85% of the baseline sample).

Continued breastfeeding, in contrast, was the strongest driver of the ICFI relationship at endline showing a strong positive relationship with child HAZ for all sample children combined and for children aged 12-36 months. Breastmilk still makes important contributions to the child diets of this region of Bolivia well into the second and third years of life, particularly with regards to fat, vitamin A and energy intakes (Berti et al, 2010). It is not surprising therefore, that continued breastfeeding predicted important differences in nutritional status for the older children in the endline sample.

Though the 24-hour diet diversity and 7-day food frequency components of the ICFI generally demonstrated expected trends in mean HAZ between low and high scores (i.e. children of mothers with lower scores had poorer growth), no associations were observed between either component and mean child HAZ. MMDA scores were likewise not associated with child growth at any time point for any age grouping of children. This suggests that though the diets of children whose mothers scored higher on the ICFI were on average more nutrient dense than the diets of children with lower-scoring mothers, these differences were not large enough to be nutritionally important. The monotonous, potato-based diets pervasive in this region of Bolivia may in part explain why these differences were not large enough to reflect differences in child growth. Seventy-one different foods were reported in 718 dietary recall questionnaires from both survey rounds, however, roots and tubers contributed on average 54% of children's dietary energy in 2009 and 58% in 2010. Though peasants in northern Potosí grow scores of varieties of potatoes, numerous cereal grains and legumes, and rear mixed herds of sheep, goats and llama, this agroecological variety is not reflected in the diets of children. Without efforts to better leverage the existing diversity of agroecosystems to improve the diversity of child diets, the differences in diversity between the “most” and “least” diverse diets from this region may remain nutritionally insignificant. Low, and potentially nutritionally unimportant variations in food diversity scores have been observed in Mali and Ethiopia as well (Arimond and Ruel, 2004).

The poor health status of children and limited access to quality health services in this region of Bolivia may also attenuate the impact of more diverse diets on child nutritional status. In 2010,

more than half of mothers reported that their child was ill in the previous two weeks with either diarrhea, cough or fever symptoms. Diarrhea symptoms were reported to persist on average for an entire week. Very few women give birth in hospital with 83% of mothers reporting that they gave birth to their most recent child at home. One-fifth of mothers reported never attending a prenatal checkup with more than 40% of those who did attend a checkup reporting first attendance only after four months of pregnancy.

The fact that the ICFI was positively associated with child nutritional status, but both of its key dietary diversity components were not, highlights both the key strength and weakness of the ICFI. By capturing multiple dimensions of child feeding practices into a single summary measure, the ICFI by design reflects the “global” impact of various individual practices, whether they are positive or negative, on overall child feeding practices (Moursi et al, 2008). This type of measure can provide program staff with critical information to understand characteristics and trends in child feeding practices as a whole in target populations and subgroups. This composite view of IYCF practices, however, can mask important associations between individual practices and outcomes of interest (Ruel and Menon, 2002; Moursi et al, 2008). Therefore, it is important to examine individual practices, in addition to the composite ICFI score, to understand which practices are driving observed relationships and to be able to target those less-improved practices for additional intervention, for example.

ICFI cutoffs

One of the main shortcomings of the ICFI is the arbitrary nature of the cutoff points used for scoring the diet diversity components of the index and for dividing the composite ICFI into “high”, “middle” and “low” feeding score groupings. However, this weakness is not unique to the ICFI, but is an issue for dietary diversity indicators in general. There are currently no recommendations for optimal diversity in the diets of children. The current Guiding Principles for Complementary Feeding of the Breastfed Child recommend that children should receive a variety of animal- and plant-source foods to meet their nutrient needs but that, “because there is so much variability in complementary food diets in different parts of the world, it is not feasible to provide global dietary ‘prescriptions’ that would guarantee adequate intake of all essential nutrients” (Dewey, 2003). Nor would it necessarily be desirable to do so. Beyond variations in breastmilk intake and the energy density of complementary foods, numerous contextual factors must be considered when formulating recommendations for improvements in IYCF practices in any particular setting. Generalizations regarding the optimal diversity of diets for non-specific populations may dissuade practitioners and program staff from sufficiently tailoring feeding messages and interventions to the peculiar foods, resources, and capacities unique to their local contexts.

The cutoffs used to derive the indicators for the WHO IYCF measures are not meant to be interpreted as recommendations for appropriate diet diversity in any particular population, but are simply thought to be reflective of “population-level progress toward optimal feeding practices” (WHO, 2008). Likewise, the cutoffs used to generate the scoring system for the ICFI

are not based on hard and fast recommendations. Sensitivity analyses were conducted for this study using different cutoff points to generate variable scores for the ICFI diet diversity components. Cutoff points for 24-hour diet diversity and 7-day food group frequency scores presented in previous research (Arimond and Ruel, 2002) closely matched those calculated for this sample which used the age-specific sample distributions of the number of food groups consumed in the previous 24 hours and raw food group frequency scores to create cutoff points for the 24-hour diet diversity and 7-day food frequency ICFI components. No differences in the main associations reported between the ICFI and child growth or measures of dietary adequacy were observed using these different cutoffs. A study using data from the Philippines found that imposing minimum portion requirements on diet diversity scores strengthened associations between the scores and nutrient adequacy and density (Daniels et al, 2009). However, limiting food groups in analyses to those from which children consumed at least ten grams did not change the ICFI cutoffs points reported in **Table 3** and similarly did not change or strengthen the results of the analyses presented.

Comparison of indicators

The WHO “minimum acceptable diet” indicator was not associated with mean child HAZ in bivariate or multivariate analyses in either data set despite the strong positive association found between the indicator and both child energy intake and nutrient adequacy. The difference in adjusted mean HAZ between children of mothers who met the minimum acceptable diet criteria and those who did not was -0.1 Z-scores in 2009 (i.e. children of mothers *not* achieving the acceptable diet standard had more positive HAZ) and 0.1 Z-scores in

2010. Only a small percentage of children in either sample actually achieved this minimum acceptable diet, however. That percentage increased from 13.5% at baseline to 33.3% at endline.

This indicator combines information on “minimum dietary diversity” and “minimum meal frequency” into a single summary indicator. For this reason, it is the WHO indicator most directly comparable to the ICFI. There are important differences between the two measures, however. For example, the WHO indicator 1) does not incorporate information on breastfeeding, bottlefeeding or food frequency consumption in the previous week, 2) for its “minimum dietary diversity” component, all children 6-23 months must meet the same standard of diet diversity to achieve the same score, 3) it does not include information on children older than 23 months, and 4) it produces a bivariate response (i.e. “acceptable” or “unacceptable” diet). The WHO IYCF indicators are designed for use in large-scale surveys and national programs. The lack of association found between the WHO summary indicator and child HAZ may be a result of the smaller sample size employed in this study. However, two large-sample studies using DHS survey data from Zimbabwe (Mduduzi et al, 2010) and Uganda (Ickes, personal communication) also found no relationship between this indicator and child HAZ. Because the indicator only takes two values and requires six-month-old infants and two-year-old children to achieve the same level of dietary diversity to receive the same adequacy standing, it may fail to detect differences in growth generated by smaller differences in IYCF practices. Not surprisingly, in the younger baseline sample, a smaller percentage of children were able to meet the “4 or more food groups in the previous 24 hours” cut-off for the

“minimum dietary diversity” indicator compared to children in the endline sample, nearly half of whom were older than one year of age and able to consume a wider variety of foods than infants.

The “minimum acceptable diet” indicator may also fail to represent more enduring child feeding practices to the same extent as the ICFI. The relatively large intra-subject variation in daily food intake lowers the precision of estimates of individuals’ usual food intakes based on single 24-hour diet recalls (Gibson, 2005). The ICFI relies primarily on cross-sectional 24-hour recall data and the WHO summary indicator relies exclusively on these data. For this reason, both tools should only be used to make assessments of dietary adequacy at the population level. However, the 7-day food group frequency component of the ICFI adds an additional time vector to the index that accounts for feeding behaviors beyond the past 24 hours. Though the recall period for the 7-day food group frequency is greater as compared to 24-hour recall methods, food frequency questionnaires over longer recall periods have been shown to produce valid estimates of intakes of foods grouped into categories (Mullen et al, 1984). Particularly for infants and young children, and particularly in resource-poor environments where smaller quantities and varieties of foods are consumed, 7-day food group frequency data may add to the ICFI’s ability to reflect more persistent IYCF practices. One study found that ICFI scores for the same cohort of 363 children remained stable at each of three time points over the course of seven months even though individual component scores changed over that time period (Moursi et al, 2008). This suggests the ICFI indeed reflects more enduring child feeding behaviors and confirms the previously-stated strength of the ICFI to encompass a series of

positive and negative practices into a holistic measure that assesses the general direction of child feeding practices.

Both the ICFI and the WHO indicators meet the need for relatively simple measures of IYCF practices. For the current study, detailed dietary information was collected from mothers to construct the ICFI and to conduct more thorough dietary analyses. However, information on food group consumption is all that is needed to construct the dietary diversity components of the index. IYCF practices, regardless of how they are measured, should be considered individually and collectively. While both the ICFI and the WHO indicators allow opportunities to do this, they seem ideally suited for different purposes.

The ICFI score, more so than the “minimum acceptable diet” indicator, provides a continuum of values that can detect smaller differences in feeding practices. This is true even when the ICFI score is grouped into terciles. For smaller, community-based programs interested in evaluating even moderate impacts on IYCF practices resulting from their programs, the use of an indicator that can detect more subtle changes in feeding practices is particularly beneficial. These programs may unfold over several years and see large impacts only after the program has had time to mature. Periodic and precise monitoring data to document incremental progress and respond accordingly are no less important for these smaller-scale programs, however. While the WHO IYCF indicators seem particularly well suited for making national and sub-national comparisons of IYCF practices and describing broad trends over time from a bird’s eye view, the ICFI, more so than any of the WHO IYCF indicators, may be a more appropriate measure to

assess incremental changes in multiple IYCF practices, especially those resulting from smaller-scale programs purposefully aimed at improving numerous practices simultaneously.

Study weaknesses

Previous authors have remarked that child feeding practices may be endogenous to multiple regression models using child nutritional status as an outcome (Ruel and Menon, 2002; Arimond and Ruel, 2002). No suitable instrumental variables were identified from available data to address this concern and so the problem of endogeneity remains a limitation of these analyses.

Selection bias may be present in this study in part because participating communities were not randomly selected. Limited staff resources were available for survey and programmatic work which necessitated targeting communities with at least five families with infants or young children. This targeting, therefore, excluded extremely small “hamlet” communities from the sample. Families in participating communities also self-selected to participate in household surveys. Survey coverage was high with more than 90% of eligible families participating in either survey round. Non-participating eligible families for which data were available (from previous or subsequent survey rounds) were compared to participating families for several household- and maternal-level characteristics. No differences in maternal education, maternal age, household size, animal ownership or agricultural production were observed between participating and non-participating families in either survey round. This suggests that selection bias resulting from families missing the opportunity to participate in either of the baseline or

endline surveys did not strongly influence results.

Though not a weakness of this study in particular, the use of an ICFI or the WHO IYCF indicators to assess IYCF practices neglects to account for several key aspects of child feeding, most notably, responsive feeding and aspects of psycho-social care. This critical dimension of child feeding is not as amenable to quantification in an indicator or index as other aspects of child feeding, but is equally if not more important and should therefore be incorporated explicitly into programs as a target outcome for monitoring and improvement (Pelto et al, 2003).

Conclusion

Child feeding indicators that can be easily measured and applied are needed to assist program staff and practitioners in monitoring nutrition programs of all sizes. In particular, agriculture and rural development programs that seek to improve nutrition outcomes through a package of agricultural inputs and nutrition-related behavior change communication strategies, may not immediately observe improvements in anthropometric indicators. Such programs may wish to collect data on upstream indicators such as diet diversity and child feeding practices that can reflect incremental progress toward a longer-term goal. Based on its 1) strong, positive association with child growth and dietary adequacy, its ability to 2) reflect usual child feeding behaviors, 3) measure the adequacy of IYCF practices as a continuum and therefore detect small, yet biologically meaningful differences in IYCF practices , and 4) track multiple feeding practices simultaneously in one summary indicator, an infant and child feeding index may be an appropriate monitoring tool for agricultural programs interested in tracking even small,

incremental changes to IYCF practices in their target populations. The comparative strength of the WHO IYCF indicators, on the other hand, lies in their ability to describe populations, assess national trends and identify at-risk populations using national survey data. Future research should continue to test associations between the WHO IYCF indicators and child growth to understand their usefulness as indicators of child nutritional status. However, the use of summary measures of child diets like the ICFI may prove to be more beneficial to program managers, particularly those managing smaller-scale, community-based programs interested in long-term nutritional change resulting from multiple program inputs. These summary measures and their associations with child growth and dietary adequacy should therefore continue to be assessed in these contexts.

References

Alvarado BE, Tabares RE, Delisle H, Zunzunegui M. Creencias maternas, prácticas de alimentación, y estado nutricional en niños Afro-Colombianos. Archivos Latinoamericanos de Nutrición 2005;55(1):55-63.

Arimond M and Ruel MT. Assessing care: progress towards the measurement of selected child care and feeding practices, and implications for programs. Food Consumption and Nutrition Division, Discussion Paper 119. Washington, DC: International Food Policy Research Institute, 2001.

Arimond M and Ruel MT. Progress in developing an infant and child feeding index: an example using the Ethiopia Demographic and Health Survey 2000. FCND discussion paper no. 143. Washington, DC: IFPRI, 2002.

Arimond M and Ruel MT. Dietary Diversity Is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys. J Nutr 2004;134:2579-2585.

Armar-Klemesu M, Ruel MT, Maxwell DG, Levin CE, Morris SS. Poor Maternal Schooling Is the Main Constraint to Good Child Care Practices in Accra. J Nutr 2000;130:1597-1607.

Asociación de Municipios del Cono Sur (AMDECO). Comunidades por Cantón y Sub Centrales: Elaboración Propia. Cochabamba, Bolivia: Asociación de Municipios del Cono Sur, 2009.

Becquet R, Leroy V, Ekouevi DK, Viho I, Castetbon K, Fassinou P, Dabis F, Timite-Konan M, ANRS 1201/1202 Ditrane Plus Study Group. Complementary Feeding Adequacy in Relation to Nutritional Status Among Early Weaned Breastfed Children Who Are Born to HIV-Infected Mothers: ANRS 1201/1202 Ditrane Plus, Abidjan, Côte d'Ivoire. Pediatrics 2006;117(4):e701-e710.

Berti PR, Jones AD, Cruz Y, Larrea S, Borja R, Sherwood S. Assessment and characterization of the diet of an isolated population in the Bolivian Andes. American Journal of Human Biology 2010;22:741-749.

Blaney S, Beaudry M, Latham M. Determinants of undernutrition in rural communities of a protected area in Gabon. Public Health Nutrition 2009;12(10):1711-1725.

Brown KH, Dewey K, Allen L. Complementary Feeding of Young Children in Developing Countries: A Review of Current Scientific Knowledge. Geneva, Switzerland: World Health Organization, 1998.

Brown KH, Peerson JM, Allen LH. Effect of zinc supplementation on children's growth; a meta-analysis of intervention trials. In: Role of Trace Elements for Health Promotion and Disease Prevention (Sandstrom B, Walter P, eds.), pp. 76-83. Switzerland: Karger, Basel, 1998.

Byass P, Hounton S, Ouédraogo M, Somé H, Diallo I, Fottrell E, Emmelin A, Meda N. Direct data capture using hand-held computers in rural Burkina Faso: experiences, benefits and lessons learnt. *Tropical Medicine and International Health* 2008;13:S25-30.

Caulfield LE, Huffman SL, Piwoz EG. Interventions to improve intake of complementary foods by infants 6 to 12 months of age in developing countries: Impact on growth and on the prevalence of malnutrition and potential contribution to child survival. *Food and Nutrition Bulletin* 1999;20(2):183-200.

Centro Nacional de Alimentación y Nutrición, Instituto Nacional de Salud. Tablas Peruanas de Composición de Alimentos, 8th ed. Lima, Perú: Ministerio de Salud, 2009.

Cogill B. Anthropometric Indicators Measurement Guide. Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, D.C., 2003.

Comité Técnico del Consejo Nacional de Alimentación y Nutrición. Desnutrición Cero al 2010: compromiso multisectorial (Primera Aproximación). La Paz, Bolivia: Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006.

Cruz Y, Jones AD, Berti PR. Prácticas de Lactancia Materna, Alimentación Complementaria y Cuidados del Infante en el Norte de Potosí – Bolivia. *Archivos Latinoamericanos de Nutrición* 2010;60(1):7-14.

Daniels MC, Adair LS, Popkin BM, Truong YK. Dietary diversity scores can be improved through the use of portion requirements: an analysis in young Filipino children. *European Journal of Clinical Nutrition* 2009;63:199-208.

Dewey KG. Guiding principles for complementary feeding of the breastfed child. Washington, DC, Pan American Health Organization/World Health Organization, 2003.

Dewey KG, Cohen RJ, Arimond M, Ruel MT. Developing and Validating Simple Indicators of Complementary Food Intake and Nutrient Density for Breastfed Children in Developing Countries. Report submitted to: the Food and Nutrition Technical Assistance (FANTA) Project/Academy for Educational Development (AED), September 2005.

Garg A, Chadha R. Index for Measuring the Quality of Complementary Feeding Practices in Rural India. *J Health Popul Nutr* 2009;27(6):763-771.

Gibson RS. Principles of nutritional assessment. New York: Oxford University Press, 2005.

Hatløy A, Hallund J, Diarra MM, Oshaug A. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition* 2000;3(1):57-65.

Institute of Medicine of the National Academies. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Otten JJ, Hellwig JP, Meyers LD, eds. Washington, DC: The National Academies Press, 2006.

Instituto Nacional de Estadística. Ministerio de Hacienda. Gobierno de Bolivia. La Paz, Bolivia, 2004. [online]. Available at <http://static-200-105-141-238.accelerate.net/geoclip/launchmap.php>. Accessed 18 October 2010.

Kolenikov S and Angeles G. *The use of discrete data in PCA: theory, simulations, and applications to socio-economic indices*. CPC/Measure Working Paper no. WP-04-85. University of North Carolina, 2004.

Lai J, Yin S, Yang X, Ma G. Distribution of feeding index and association between feeding index and growth of infants and young children aged 6-24 months. *Journal of Hygiene Research* 2005;34:617-620.

Lutter CK, Mora JO, Habicht JP, Rasmussen KM, Robson DS, Herrera MG. Age-specific responsiveness of weight and length to nutritional supplementation. *American Journal of Clinical Nutrition* 1990;51:359-364.

Martorell R, Khan LK, Schroeder DG. Reversibility of stunting: epidemiological findings in children from developing countries. *European Journal of Clinical Nutrition* 1994;48:S45-S57.

Martorell R, Scrimshaw NS. The effects of improved nutrition in early childhood: The Institute of Nutrition of Central American and Panama (INCAP) follow-up study. *J Nutr* 1995;4S.

Mduduzi N.N. Mbuya MNN, Chidem M, Chasekwa B, Mishra V. Biological, Social, and Environmental Determinants of Low Birth Weight and Stunting among Infants and Young Children in Zimbabwe. Zimbabwe Working Paper no. 7. Calverton, Maryland: ICF Macro, 2010.

Ministerio de Salud y Deportes, Gobierno de Bolivia. Tabla Boliviana de Composición de Alimentos, 4th ed. La Paz, Bolivia: Ministerio de Salud y Deportes, Gobierno de Bolivia, 2005.

Moursi MM, Martin-Prével, Eymard-Duvernay S, Capon G, Trèche S, Maire B, Delpuech F. Assessment of child feeding practices using a summary index: stability over time and association with child growth in urban Madagascar. *Am J Clin Nutr* 2008;87:1472-9.

Moursi MM, Trèche S, Martin-Prével Y, Maire B, Delpuech F. Association of a summary index of child feeding with diet quality and growth of 6-23 months children in urban Madagascar. *European Journal of Clinical Nutrition* 2009;63:718-724.

Mullen BJ, Krantzler NJ, Grivetti LE, Schutz HG, Meiselman HL. Validity of a food frequency questionnaire for the determination of individual food intake. *American Journal of Clinical Nutrition* 1984;39:136-142.

Ntab B, Simondon KB, Milet J, Cissé B, Sokhna C, Boulanger D, Simondon F. A Young Child Feeding Index Is Not Associated with Either Height-for-Age or Height Velocity in Rural Senegalese Children. *J Nutr* 2005;135:457-464.

Pelto GH, Levitt E, Thairu L. Improving feeding practices: Current patterns, common constraints, and the design of interventions. *Food and Nutrition Bulletin* 2003;24:45-82.

Penny ME, Creed-Kanashiro HM, Robert RC, Narro MR, Caulfield LE, Black RE. Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster-randomised controlled trial. *Lancet* 2005;365:1863–72.

Ruel MT, Levin CE, Armar-Klemesu M, Maxwell D, Morris SS. Good Care Practices Can Mitigate the Negative Effects of Poverty and Low Maternal Schooling on Children's Nutritional Status: Evidence from Accra. *World Development* 1999;27:1993-2009.

Ruel MT, Menon P. Child feeding practices are associated with Child Nutritional Status in Latin America: Innovative Uses of the Demographic and Health Surveys. *J Nutr* 2002;132:1180-1187.

Ruel MT. Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities. *J Nutr* 2003;133:3911S-3926S.

Saha KK, Frongillo EA, Alam DS, Arifeen SE, Persson LA, Rasmussen KM. Household Food Security Is Associated with Infant Feeding Practices in Rural Bangladesh. *J Nutr* 2008a;138:1383-1390.

Saha KK, Frongillo EA, Alam DS, Arifeen SE, Persson LA, Rasmussen KM. Appropriate infant feeding practices result in better growth in infants and young children in rural Bangladesh. *Am J Clin Nutr* 2008b;87:1852-9.

Savy M, Martin-Prével Y, Sawadogo P, Kameli Y, Delpeuch F. Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *European Journal of Clinical Nutrition* 2005;59:703–716.

Sawadogo PS, Martin-Prével Y, Savy M, Kameli Y, Traissac P, Traoré AS, Delpeuch F. An Infant and Child Feeding Index Is Associated with the Nutritional Status of 6- to 23-Month-Old Children in Rural Burkina Faso. *J Nutr* 2006;136:656-663.

Sawadogo PS, Martin-Prével Y, Capon G, Traoré SA, Delpeuch F. Nutritional status and common infections in infants in Burkina Faso: interest of an 'overall morbidity score'. *Tropical Medicine and International Health* 2008;13:345-353.

Shrimpton R, Victora CG, de Onis M, Costa Lima R, Blössner M, Clugston G. The Worldwide Timing of Growth Faltering: Implications for Nutritional Interventions. *Pediatrics* 2001;107:e75.

Srivastava N, Sandhu A. Index for Measuring Child Feeding Practices. *Indian Journal of Pediatrics* 2007;74:363-368.

Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition* 2006;9(5):644-650.

Ulijaszek SJ. Measurement error. In: *The Cambridge Encyclopedia of Human Growth and Development* (Ulijaszek SJ, Johnston FE, Preece MA, eds.), p. 28. UK: Cambridge University Press, 1998.

UNICEF. Strategy for Improved Nutrition of Children and Women in Developing Countries. United Nations Children's Fund, 1990.

U.S. Department of Agriculture, Agricultural Research Service. 2010. USDA National Nutrient Database for Standard Reference, Release 23. Nutrient Data Laboratory Home Page, <http://www.ars.usda.gov/ba/bhnrc/ndl>.

Vanek S. Soil gradients and legumes in mountain agroecosystems: N and P cycling and legume functional attributes in the Bolivian Andes. Doctoral dissertation. Cornell University, Ithaca, NY, 2010.

Victora CG, de Onis M, Hallal PC, Blössner M, Shrimpton R. Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions. *Pediatrics* 2010;125:e473-e480.

Wang Y, Chen C, He W. Study of establishing feeding index for children aged 6-23 months in rural China. *Journal of Hygiene Research* 2009;38:304-307.

World Health Organization. Indicators for assessing breastfeeding practices. Geneva, Switzerland: World Health Organization, 1991.

World Health Organization. The optimal duration of exclusive breastfeeding: Report of an Expert Consultation. Geneva, Switzerland: World Health Organization, 2001.

World Health Organization Multicentre Growth Reference Study Group. WHO child Growth Standards: Length/Height for Age, Weight for Age, Weight for Length, Weight for Height and Body Mass Index for Age. Methods and Development. World Health Organization: Geneva, 2006.

World Health Organization. Indicators for assessing infant and young child feeding practices. Part 1: Definitions. Geneva, Switzerland: World Health Organization Press, 2008.

Zhang J, Shi L, Wang J, Wang Y. An infant and child feeding index is associated with child nutritional status in rural China. *Early Human Development* 2009;85:247-252.

4. Women's participation in agriculture poses a significant barrier to improving infant and young child feeding practices in an agropastoralist region of the Bolivian Andes

4.1 Introduction

The potential for agriculture to address problems of undernutrition in low-income countries has long been recognized (Pinstrup-Andersen, 1981). Beginning with the sea change in agricultural production that began in the 1960s with the expanded use of high-yielding crop varieties, chemical inputs and irrigation, agricultural investments have been widely successful at expanding food production (IFPRI, 2002). They have not, however, demonstrated similar success at improving nutrition, particularly undernutrition among young children. Proper child development and nutrition depend not only on household food and livelihood security, but equitable access to resources by women within households, the accessibility of adequate care for mothers and children as well as healthy home environments (World Bank, 2006).

Programmatic evidence and experience have consistently concluded that women are the nutritional gatekeepers for households, assuring that these underlying determinants of proper nutrition are achieved. Therefore, it is not surprising that investments in agriculture and rural development, narrowly focused on improving production with no explicit goal of improving the capacities of women as food producers and/or caregivers, have often failed to show improvements in nutrition indicators (Niemeijer et al, 1988; Kurth, 1989; Nielsen et al, 2003; Roos et al, 2003).

Women comprise 43 percent of the agricultural sector labor force of developing countries (FAO, 2011) and contribute 60-80 percent of the labor that produces subsistence crops in many countries of Sub-Saharan Africa (Dao, 2004). Research centered on the interactions between women and agricultural systems has tended to emphasize the constraints women face to improved agricultural productivity. These constraints are numerous, varied and have been well-documented. They include: weak land and water use rights, limited access to common property resources, lack of equipment and appropriate technology, limited contact with agricultural extension, low levels of education, and lack of access to cooperatives and producer associations, inputs, credit and labor markets (Quisumbing et al, 1995; Cramer and Wandira, 2010; Quisumbing and Pandolfelli, 2010). These constraints contribute to the lower agricultural productivity of women farmers compared to their male counterparts, even within analogous levels of socioeconomic status (Udry et al, 1995; Quisumbing, 1996; Quisumbing et al, 1998). One review of the literature revealed that male farmers across a variety of world regions, farming systems, crops and time periods consistently outproduced women farmers with yield gaps ranging from 20-30 percent (Peterman et al, 2010).

This primary emphasis on productivity differentials in gender-focused analyses of agriculture is reflected in recent reviews of the literature examining pathways from agriculture to improved nutrition that emphasize food production pathways. These include: increases in food availability via increased production, increases in income through increased production for sale in markets, reductions in real food market prices through increased production, and agricultural growth at the national level resulting from expanded production (World Bank, 2007; Arimond

et al, 2010). However, while the potential benefits to household food security of improved household agricultural production have been examined, the implications of changes to production systems on maternal and child care, an underlying determinant of child undernutrition (UNICEF, 1990), have received relatively little attention. The above-mentioned literature reviews and others (Berti et al, 2004) have also highlighted women's knowledge and control of household resources as another important pathway from agriculture to improved nutrition. The implications of this pathway on how women are able to feed and care for themselves and young children have similarly received little attention. Rather, emphasis has been placed on the potential for women's increased control of resources to improve their agricultural productivity and/or earnings, two outcomes that are likely to improve child nutrition outcomes.¹⁴ This emphasis underscores women's potential to influence agricultural systems and rural economies by generating higher yields and more income through production activities. These systems and economies in turn, however, strongly affect women, particularly with respect to their capacities as caregivers of children.

The concept of "care" was first defined in the UNICEF conceptual framework of the determinants of child malnutrition as "the provision in the household and the community of time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members" (UNICEF, 1990). Six categories of care were subsequently identified including: 1) care for pregnant and lactating women, 2) breastfeeding and the feeding

¹⁴ Numerous studies demonstrate that income controlled by women, often resulting from the production of crops controlled by women, is more likely to be invested in the health and nutrition of children than income controlled by men (Kennedy and Cogill, 1987; Hoddinott and Haddad, 1994; Katz, 1994; Ward-Batts, 1996; Rogers et al, 1996; Doss, 1997).

of very young children, 3) psychosocial stimulation of children and support for their development, 4) food-preparation and food storage behavior, 5) hygiene behavior, and 6) care for children during illness, including health-seeking behavior (Engle, 1992). There are multiple pathways through which rural livelihoods and participation in agricultural production activities might affect these care practices (see **Figure 1**). For example, women's time allocation to agricultural labor detracts from dedicated time spent to child care activities. High agricultural workloads, occupational health risks, as well as exposure to toxins and disease associated with agricultural production systems can deleteriously affect women's health and nutrition which has direct implications for child nutrition via low birthweight (Kramer, 1987; Wu et al, 2004), poor lactational performance (Rasmussen, 1992), and potentially poorer child feeding behaviors. However, though theorized, few data are available to elucidate the importance of any one of these pathways over the others or to provide a more nuanced understanding of how agriculture affects women in their role as caregivers.

The following paper examines the multiple barriers that women face to improving infant and young child feeding (IYCF) practices, a core component of care, in the rural highlands of central Bolivia. Families in this region of Bolivia largely depend on subsistence farming as their primary means of livelihood and women are integrally involved in agricultural production activities as both farmers and herders. Therefore, this context provides the opportunity to explore the relationship between the rural livelihoods of women, their participation in agriculture and their child feeding practices. As a catalyst to understanding this relationship, an eight-month, agriculture-centered nutrition intervention was implemented in communities of this region in

2009-2010 to determine if promotion of changes to families' use of local agricultural resources and women's behaviors as agriculturalists could improve IYCF practices. This paper seeks to determine: 1) the extent and nature of the adoption of improved IYCF practices among mothers participating in the intervention (i.e. mothers in treatment communities), 2) the kinds of barriers mothers face to improving IYCF practices, which of these barriers are predominantly encountered and which, if any, are specifically related to agriculture, 3) the characteristics of households and mothers who face varying kinds of barriers to improving IYCF practices at varying degrees of intensity, and 4) the relationship between the barriers to improved child feeding encountered by mothers, both the number and kinds, to the adoption of improved IYCF practices.

4.2 Subjects & Methods

Intervention approach

The nutrition intervention and the evaluation research that accompanied it were conducted in collaboration with the non-governmental organization (NGO), World Neighbors – Bolivia (WNB). Though historically focused on sustainable agriculture and family planning programming, in 2005 WNB began collecting child anthropometric and household dietary data as well as ethnographic data on IYCF practices in northern Potosí to lay the foundation for future activities aimed at improving maternal and child nutrition.

The intervention was conducted as a pilot program in a relatively small number of initial communities. Based on its impact, regional Ministry of Health offices were to scale up the intervention and incorporate it into their ongoing, monthly community visits. At the time of this research, these visits included little to no emphasis on maternal and child nutrition.

The core of the intervention emphasized a modified, consultative research methodology known as Trials of Improved Practices (TIPs) (Dickin et al, 1997). This research method employs interactive information-gathering and feedback sessions with mothers and program beneficiaries to identify feasible, acceptable, and effective strategies to improve nutrition-related behaviors (Dickin et al, 1997). Normally, this method is used as a tool for formative research, however, in this context the research team employed it not only as a research tool, but also as an intervention mechanism to 1) strengthen caregivers' abilities to adopt new recipes, IYCF practices, and related behaviors and agricultural practices by engaging them directly in the shaping of those recipes, behaviors, and practices and 2) creating spaces for caregiver-led, individual and group feedback sessions to adapt behaviors and improved practices based on emerging needs and lessons learned. Though the TIPs process helped the research team to refine program messages and continue learning about existing IYCF practices in northern Potosí (particularly those barriers to closing identified gaps in proper IYCF practices), a large amount of formative research had already been completed prior to the intervention (Cruz et al, 2010; Berti et al, 2010) that informed the broad intervention strategy, namely, leveraging agriculture and women's roles as agriculturalists as an entry point for improving IYCF practices. Therefore, the TIPs process was utilized as a tool for participatory

behavioral transformation as well as a primary research tool.

The research team planned to visit each community six times from June 2009 to January 2010 to implement an agriculture-centered nutrition education intervention focused on improving IYCF practices using locally-available resources. **Table 8** describes the content and focus of each community visit.

Each series of community visits began with an introductory session identifying locally-raised crops and animals, the seasonality of available foods in the community, commonly-fed complementary foods for weaned infants and young children, and other IYCF practices. During this first visit, five broad feeding messages were introduced, based on the above-mentioned formative research that identified the most critical gaps in child diets and IYCF practices. These messages were then discussed with participants to make explicit their common understanding of the messages and begin to tailor them to the specific context of child feeding in each community. These context-adapted messages were then promoted throughout the course of entire nutrition intervention. The five broad feeding messages promoted included: 1) improving the diversity of child diets, 2) improving the energy density of complementary foods, 3) increasing the frequency of daily feedings, 4) feeding appropriately during and after illness (i.e. increasing fluid intake, including breastmilk, and maintaining an adequate diet during illness; feeding more often after illness), and 5) exclusively breastfeeding to six months of age and maintaining frequent breastfeeding until two years of age.

Table 8. Description of educational content areas and principal activities conducted during each community visit of the nutrition education intervention.

Visit Number (Month)	Educational content areas and principal activities
Group visit 1 (June/July 2009)	Local agrobiodiversity, foods and seasonal availability of those foods in the community 5 key IYCF practices Recipe trials to create improved complementary food recipes appropriate for infants and young children Taste testing trials of new recipes with infants and young children Planning session for each caregiver to identify specific recipe(s) and improved IYCF practice(s) to adopt during the coming two weeks Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver
Home visit 1 (2 weeks after visit 1)	Follow-up home visits to mothers to 1) learn about caregivers' ability and willingness to adopt new recipes and IYCF practices, 2) identify enabling and constraining factors to change, 3) counsel and encourage caregivers to continue improved practices and family members to support caregivers in their efforts, and 4) discuss change strategies based on identified barriers to improving IYCF practices and emerging lessons 24-hour child dietary data collection Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver
Group visit 2 (August 2009)	Review of improved recipes and five key IYCF practices Barriers to exclusive breastfeeding to six months and partial breastfeeding to two years Feeding during and after illnesses Feeding in the field and women's roles as farmers and herders Intra- and inter-community social networks; potential for pooling resources Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver
Group visit 3 (September 2009)	Review of improved recipes and five key IYCF practices Review of lessons from group visit 2 Follow-up to feeding in the field and women's roles as farmers and herders Follow-up to intra- and inter-community social networks; potential for pooling resources Participatory video introduction and activities (with peer-to-peer training and videotaping of experiences with new recipes and IYCF practices) Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver
Home visit 2 (October 2009)	Follow-up home visits to mothers to 1) learn about caregivers' ability and willingness to adopt new recipes and IYCF practices, 2) identify enabling and constraining factors to change, 3) counsel and encourage caregivers to continue improved practices and family members to support caregivers in their efforts, and 4) discuss change strategies based on identified barriers to improving IYCF practices 24-hour child dietary data collection Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver
Group visit 4 (January 2010)	Review of improved recipes and five key IYCF practices Community-led needs assessment (problem tree and brain storming session to identify existing community resources to meet needs and those needs gaps requiring external inputs) Planning session for future nutrition-related development activities Growth monitoring & promotion; discussion and charting of child's growth on growth chart retained by caregiver

Participatory recipe trials to create improved complementary feeding recipes for infants and young children that incorporated these feeding messages were conducted during initial community visits. These trials and promotion of the core feeding messages outlined above served as the educational foundation upon which subsequent intervention activities were based. However, given the insights from the formative research conducted prior to the start of the intervention as well as the feedback from women that began to emerge immediately following initial community visits, it was clear that basic nutrition education was not sufficient to catalyze behavior change, and that women faced considerable barriers, beyond just knowledge deficits, to improving their IYCF practices. Many of these barriers were linked to the quality of local agricultural production and women's participation in agricultural labor activities. Therefore, in response to these emergent data, the research team sought ways to increase the local availability of diverse foods, increase women's time availability and make women's time spent in agricultural labor activities more conducive to proper child feeding. Intervention strategies then focused on intra- and inter-community pooling of resources to maximize the diversity of foods available to households with young children (i.e. families with a larger diversity of crops, with access to crops in different agroecological zones or with access to relatives' crops would trade these to families with young children for other goods or services). Intervention activities also promoted sharing pasturing responsibilities within and between families throughout the week and while in the field to make more time available to mothers of young children (i.e. women with young children would be prioritized by mothers-in-law, relatives and neighbors to spend more time at home rather than in the field and to spend more of their time in the field dedicated to child care activities). The intervention also sought to

strengthen women's social networks. One tool used to facilitate this strategy was participatory video (Lunch and Lunch, 2006) wherein women themselves used simple camera equipment to create short videos recounting their experiences with child feeding and barriers to improving IYCF practices. These videos were then viewed during community meetings and shared between communities to create broad awareness of the importance of child feeding issues and strengthen women's connections with caregivers in neighboring communities. Improved agronomic practices to support more diverse production systems were also promoted.

As part of the modified TIPs process, follow-up home visits were conducted in each community at two time points: approximately one week following the initial recipe trial and three months later. These two rounds of visits allowed the field team to 1) learn about the ability and willingness of caregivers to adopt new recipes and improved IYCF practices, 2) identify enabling and constraining factors to change, 3) counsel and encourage caregivers to continue improved practices and family members to support them in their efforts, and 4) discuss change strategies based on emerging lessons and identified barriers to improving IYCF practices. Growth monitoring and promotion activities were also carried out during these home visits as well as during community group visits.

Data collection & sampling

Household survey: A large-scale household survey was conducted in March 2009 before the start of the intervention and again in March 2010 after completion of the intervention in those communities both participating in intervention activities as well as in control communities

where no intervention activities took place. These surveys were conducted largely to evaluate the impact of the intervention on IYCF practices in treatment communities, but also to support analyses emerging from data collected during TIPs follow-up home visits. A description of the methods used to conduct this survey as well as the endline survey that was conducted one year later is provided in **Chapter 3**.

The use of hand-held computers for data collection facilitated immediate access to the survey data and thus a rapid turnaround in the analysis of community baseline characteristics.

Following the March 2009 survey, communities were conditionally assigned to treatment and control groups such that there were no differences in the mean baseline values of the following characteristics between treatment and control communities: child age, community elevation, caregivers' scores on a child feeding index, and several indicators of household socioeconomic status. In addition, communities were assigned to treatment groups to reflect a balance in the size of the community (number of households and land area), the number of households with infants and young children in the community, the relative accessibility of the community (distance from and difficulty in accessing main roads), and the community's location with respect to agroecological zones. Thirty-one communities were assigned to the control group and thirteen communities to the treatment group. The decision to assign a certain number of communities to each group was based on two considerations: 1) attaining sufficient power to detect differences in caregivers' scores on a child feeding index between treatment groups, and 2) acknowledging the ability of the NGO and collaborating researchers to intervene in a select number of communities given limited human resources (the research field team included only

2-3 field personnel at any given time).

Semi-structured, in-depth interviews: Ninety-three semi-structured, in-depth interviews were conducted with 69 different mothers from all 13 treatment communities in July and October 2009 during the two rounds of TIPs follow-up home visits. Fifty-two interviews were carried out in July 2009 during the first round of visits and 41 in October 2009 during the second round of visits, 24 of which were follow-up interviews with mothers from the July round of interviews. Interviews lasted approximately 40 minutes (mean duration of 37.7 minutes for first-round interviews and 44.6 minutes for second-round interviews).

Households participating in TIPs follow-up home visits were purposively selected in each treatment community based on a positive deviance methodology (Wishik and Van der Vynckt, 1976; Marsh et al, 2004). Families were identified whose children were better nourished (according to baseline child growth data) and where the mother's IYCF practices were better (again, according to baseline data on IYCF practices) relative to other families within the same community. Likewise, families were also interviewed in which child growth and IYCF practices were "negatively deviant", that is, relative to other families within the same community children in these families were growing more poorly and mothers exhibited poorer IYCF practices. Once positively and negatively deviant households were identified and interviewed, some families in each community in which child growth and IYCF practices were closer to the mean value of the community sample distribution of those variables were also selected for interviewing. The research team also sought to sample households that were both relatively

centrally located within the community as well as those more isolated households. This sampling approach was taken to ensure that a wide range of social behaviors and maternal experiences with infant and young child feeding would be represented in the sample. The inclusion of positively deviant families in the sample also ensured that these families' strategies to improving IYCF practices were explicitly voiced and shared during intervention group sessions. However, despite these efforts to achieve a representative sample, the absence of random household selection leaves the sample susceptible to selection bias.

Approximately one-half (46%) of the families interviewed during the first round of follow-up home visits were interviewed again during the second round of visits. This was intentional. The field team was able to visit only a limited number of households in each community per visit because of families' work schedules and limited availability to speak with the research team. Four follow-up home visits were made on average in each community during the first round and slightly less than that during the second round (3.4 visits on average). Therefore, the second round of follow-up home visits served not only to continue monitoring the experiences of those families interviewed during the first round, but to reach those families that were not available for interview during the initial round of house visits.

Interviews during TIPs follow-up home visits were conducted in the native Quechua language by a bilingual, Spanish-Quechua language nutritionist and qualitative researcher (YC). Interviews were not recorded. A year and a half prior to the start of these interviews, YC conducted numerous series of in-depth interviews in several communities of this same region

as part of a prolonged ethnographic research project. Based on this experience, the research team decided that recording equipment would likely harm the quality of the data collected and in some cases, prevent access to families. Nearly all interview subjects participating in TIPs follow-up home visits were women with little to no formal education, many of whom were extremely timid and even fearful around outsiders, and belonged to households and communities with guarded attitudes toward researchers. Recording equipment would almost certainly have exacerbated community-researcher tensions and may have led to deleterious impacts on the veracity of interviewee responses. Extensive field notes were taken however, during and immediately following interview sessions, including transcriptions of complete and partial quotations from interview subjects.

Interviews were semi-structured with the opportunity for interviewees to respond to open-ended questions from a number of different topic areas including: maternal experiences with changes to complementary food recipes and feeding practices, child experiences with changes to complementary food recipes and feeding practices, enabling and constraining factors to change, child health status, maternal health-seeking behavior, household agricultural production and household gender roles. TIPs interview guide materials were combined with similar, locally-adapted materials from the Process for the Promotion of Child Feeding, or ProPAN, project (PAHO, 2004). These interview guide materials facilitated mothers identifying ideal practices, actual practices, the reasons, knowledge and attitudes behind current practices, and internal and external barriers and facilitating factors to change. Previous research employing ProPAN in an urban region of Bolivia successfully identified poor child feeding

practices, the barriers to improving those practices and demonstrated that IYCF practices could be improved using only local resources (Pachón and Reynoso, 2002). Though the interviewer followed a general interview structure and covered explicit topic areas, interviews were conversational, moving fluidly from one topic to the next, going backwards and combining topics at times to ensure the interview subject was comfortable, responded honestly to questions, and provided in-depth, detailed responses to the extent possible. Detailed household observations were also recorded—for example: food on hand, child feeding practices, food preparation practices, spousal interactions, and household hygiene and sanitation using a modified, spot check hygiene index (Webb et al, 2006).

Measurement of variables

Infant and child feeding index: A composite infant and child feeding index (ICFI) was used to evaluate changes in IYCF practices resulting from the intervention program. The index was constructed as previously reported (see **Chapter 3**; Arimond and Ruel, 2002; Moursi et al, 2008) and included the following five components: 1) maintenance of any breastfeeding, 2) use of a bottle for feedings in the previous 24 hours, 3) diet diversity in the previous 24 hours, 4) food group frequency in the previous 7 days, and 5) frequency of feeding of solid or semi-solid foods.

Household food insecurity: Household food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access (Coates et al, 2007) developed by the Food and Nutrition Technical Assistance (FANTA) Project as a tool for measuring three “domains” of food insecurity found to be stable across countries and major

population subgroups (Kendall et al, 1995; Frongillo and Nanama, 2006; González et al, 2008). These domains include: anxiety and uncertainty about food access, insufficient food quality, and insufficient food intake. The generic nine-item survey was adapted to the local Bolivian context through key informant interviews with community leaders and focus group discussions with families (see **Appendix C**). A continuous, 27-point score and a four-level, categorical variable were derived from the nine-item survey for use in analyses.

Agricultural production data: Respondents were asked to recall the amount of seed they sowed in the year preceding the most recent harvest for a variety of crops including: potato, wheat, barley, maize, Andean lupin (*Lupinus mutabilis*), fava bean, pea, common bean, oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), quinoa (*Chenopodium quinoa*) as well as a variety of minor vegetable crops cultivated in kitchen gardens. Respondents were also asked to report the amount harvested for each of these crops during the most recent harvest.

Data analysis

Qualitative interview data from TIPs follow-up home visits were initially examined through a process of inductive analysis (Patton, 2002) whereby a codebook for content analysis was incrementally developed as a first step toward identifying patterns in the data. Daily field notes from interviews and household observations were shared, compiled and discussed in detail among the research team each afternoon and evening following the completion of the morning's interviews (YC, AJ and LG during the first round of home visits and YC and AJ during the second round of visits). Team members discussed the content of each interview in its

entirety and through a process of analytic triangulation developed a series of data tags for each interview that identified positive and negative feeding behaviors, and internal and external enabling and constraining factors to changing these behaviors. These tags then allowed the primary researcher (AJ) to develop a formal codebook following the completion of each round of interviews when a more comprehensive compilation of field notes and observations was carried out.

This process was distinct from that of “open coding” employed in a “grounded theory” approach (Glaser and Strauss, 1967; Strauss and Corbin, 1998), in that, the abundant literature on infant and child feeding as well as the formative research on IYCF practices among mothers in this region of Bolivia that informed this research (Cruz et al, 2010), inevitably led the research team to pursue particular lines of inquiry and exclude others. Interview questions were open-ended and designed to elicit responses that would reveal new themes and issues related to child feeding, particularly those themes related to distal factors influencing the more well-established proximal determinants of poor IYCF practices. However, the semi-structured interview guides certainly bounded the direction of the interview to some extent based on the research team’s *a priori* understanding of infant and child feeding challenges in this population and globally. Therefore, the coding process, though approached objectively with the aim to discover patterns, themes and categories in the data, was inherently biased by the researchers’ prior knowledge of child feeding practices and experiences with caregivers in this population, as well as the particular interview questions asked.

Sixty-two codes were initially developed to describe the barriers to improving IYCF practices reported from interviews and household observations. These codes were then distilled to 46 thematic areas explaining the reported barriers and further classified in 12 broad categories of barriers. These “categories”, though useful for developing theory and examining relationships, are artificial constructs and alone may not be able to capture the extent of influence that related barrier categories commonly exert on caregivers. Indeed, several of the barrier categories interact dynamically to create spheres of influence on women’s behavior in day-to-day life. Therefore, spheres, or “domains” of barriers were also created by grouping together interconnected barrier categories. All such analyses and codification of the interview data were conducted solely by the primary researcher (AJ) except for those initial discussions with the entire research team carried out immediately following home visits to compile field notes, observations and impressions and to develop broad data tags for interview content.

Deductive analytical techniques were employed to examine the authenticity of the results of the inductive content analysis (e.g. to examine the relationship between “geographic isolation” as a reported barrier and indicators of geographic isolation from household survey data) and to test hypotheses (e.g. caregivers reporting a larger number of distinct barriers to improved IYCF practices are less likely to be able improve IYCF practices) (Patton, 2002). This process of deductive analysis required the combination of coded and classified qualitative interview data with quantitative household survey data into statistical models. All statistical analyses were conducted in SAS (version 9.1, SAS Institute, Cary, NC) using the PROC GLM procedure.

Ethics

The study protocol was approved by the Cornell University Institutional Review Board for Human Participants. All individuals surveyed gave informed oral consent to participate in both the household surveys and the interviews conducted during TIPs follow-up home visits. Families received a 0.45 L bottle of vitamin A-fortified vegetable oil for each child weighed and measured as compensation for their participation in the household surveys.

4.3 Results

Survey and intervention participation

Data were collected on 337 children aged 0-26 months from 331 households at baseline in March 2009. At endline, one year later, data were collected on 436 children aged 0-36 months from 390 households; 143 of these households belonged to the 13 treatment communities in the study. Demographic, nutritional and livelihood-related descriptions of these two sample populations have been described in-depth previously (see **Chapters 2 and 3**).

In total, 222 different community members (i.e. mothers, fathers, grandmothers and young women) in thirteen communities participated in one or more community meetings throughout the eight-month intervention period. Of these individuals, 123 were mothers with infants or young children and 117 of these women participated in either the baseline or endline surveys (83 participated in both survey rounds). The research team visited the thirteen communities a total of 36 times in eight months for group activities (one to four times per community) and 25

times for individual house visits (one to two times per community) visiting 69 different households. Women who participated in at least one survey round attended on average two-thirds of all group activity meetings. **Table 9** shows the distribution of visits per community. Though six visits per community were initially planned, conflicting community work schedules, washed out roads, flooded rivers and other logistical obstacles throughout the year prevented the research team from reaching this number of visits in every community.

Ten of the 69 women interviewed during TIPs follow-up home visits did not participate in either round of the household survey; 52 participated in the baseline survey, 57 participated in the endline survey, and 50 of the women participated in both survey rounds. Valid ICFI scores were available for 39 of these women at both baseline and endline.

Improved recipes

Table 10 compares the nutrient profile of a traditional potato broth commonly fed to infants and young children in most communities of northern Potosí to the profiles of two improved complementary food recipes developed by communities during recipe trials. Improved recipes varied between communities based on the availability of local foods, community decisions made during recipe trials, and the individual initiative of mothers experimenting with new, improved recipes. However, these two recipes and slight variations on them were quite commonly created in many communities.

The enriched potato purée recipe sought to improve upon the potato-based broths and porridges that women commonly prepare by increasing the viscosity of the dish and adding a locally-available cereal grain (**Table 10** displays data for wheat though barley, quinoa and maize were also used at various locations), a legume (e.g. fava bean, pea, Andean lupin), a vegetable (almost exclusively carrots because of their wide availability in local markets and the poor availability of nearly any other vegetables) and a spoonful of vitamin A-fortified sunflower oil (another commonly available item in local markets that most families purchase throughout the year, but usually do not include in young children’s dishes). The toasted flour mixes prepared in many communities were variations of traditional toasted flour recipes already common in the region that were based on single toasted cereal grain flours. These mixes, however, included more than one toasted cereal grain flour and a toasted legume flour combined with either sugar or oil to make the recipe more energy dense and palatable. These toasted flour mixes were especially promoted as foods that could be transported in baggies or plastic containers for field feedings of young children while women pastured animals or during breaks tending to crops.

Table 9. Distribution of visits to communities for intervention group meetings and individual household visits.

Community	Participating mothers ¹	Atten ²	GV 1	HV 1	GV 2	GV 3	HV 2	GV 4	Total ³
1	8	3.1	✓	✓	✓	✓	✓	✓	4(6)
2	8	1.3	✓	✓	✓	✓	✓	✓	4(6)
3	18	1.8	✓	✓	✓		✓	✓	3(5)
4	10	2.1	✓	✓	✓		✓	✓	3(5)
5	10	1.8	✓	✓	✓	✓	✓		3(5)
6	5	2.3	✓	✓	✓	✓	✓		3(5)
7	5	3.0	✓	✓	✓	✓	✓	✓	4(6)
8	5	3.2	✓	✓	✓	✓	✓	✓	4(6)
9	9	1.9	✓	✓	✓	✓	✓		3(5)
10	12	2.6	✓	✓	✓	✓	✓	✓	4(6)
11	9	1.1	✓	✓	✓		✓		2(4)
12	10	1.4	✓	✓	✓		✓		2(4)
13 ⁴	8	1	✓	✓					1(2)
Total	117	2.0	13	13	12	8	12	7	40(65)

Abbreviations: Atten, attendance; GV, group visit; HV, home visit.

¹The number of mothers in the community with infants and/or young children who participated in at least one intervention group visit and either or both of the household surveys.

²The mean number of group visit attendances per communities by mothers with infants and/or young children who participated in at least one group visit and either or both of the household surveys.

³The total number of group visit and in parentheses, the total number of groups visits + home visits.

⁴This community declined further participation in intervention activities after the first two visits.

Table 10. Nutrient profiles of a traditional northern Potosí complementary food recipe and two examples of improved recipes created by caregivers during recipe trials.

Recipe ¹	Ingredients	Energy (kcal)	Protein (g)	Lipid (g)	Calcium (mg)	Iron (mg)	Zinc (mg)	Vitamin A (µg RAE)
<i>Traditional recipe</i>								
Traditional potato broth (164 g)	Potato, <i>chuño</i> ² , carrot, onion	118	2.2	0.13	17.3	0.74	0.33	41
per 100 g		72.2	1.4	0.08	10.6	0.45	0.20	25.2
<i>Improved recipes</i>								
Enriched potato purée (255 g)	Potato, <i>chuño</i> , carrot, onion, wheat, fava bean, oil	405	11.7	6.3	66.4	5.0	2.5	262.9
per 100 g		159	4.6	2.5	26.0	2.0	1.0	103
Toasted flour mix (236 g)	Toasted wheat, barley, and fava bean flour, sugar	249	9.0	1.4	31.9	4.3	1.9	11.3
per 100 g		106	3.8	0.59	13.5	1.8	0.79	4.8

¹The masses shown for individual recipes are for the typical amount consumed by children during taste test trials and per 100 g. The mass of improved recipes consumed is nearly double that of the traditional recipe because of the difference in density between the two recipes. The same mass of the improved recipes occupies less volume and is therefore denser than the traditional recipe, allowing a greater mass to occupy the same volume in the child's dish (and stomach).

²"*Chuño*" is freeze-dried potato.

Both improved recipes show improved energy and nutrient density (amount of nutrient per 100 g) over the traditional recipe for all the nutrients shown in **Table 10** including: protein, lipid, calcium, iron and zinc. The enriched potato purée recipe also showed improved vitamin A content over the traditional recipe. However, the toasted flour mix showed a lower vitamin A content than the traditional recipe. When vitamin A-fortified sunflower oil was added to the toasted flour mixture (which many mothers chose to do instead of adding sugar), the vitamin A content was sharply increased over the traditional recipe.

Adoption of improved IYCF practices

Table 11 presents data on mothers' reporting of changed IYCF practices during the TIPs follow-up home visits that occurred following the initial community recipe trials as well as reported adoption of specific improved IYCF practices by mothers during the endline household survey in March 2010. A high percentage of women interviewed during the first and second TIPs follow-up home visits participated in both the initial recipe trial (90% and 76%, respectively) and subsequent intervention group visits (75% and 80%, respectively, participated in two or more intervention group visits). Less than 10% of those women interviewed in either round of follow-up home visits did not participate in any intervention visits. However, the participation of women from treatment communities interviewed during the endline household survey was considerably more varied. Nearly a quarter of the sample (24%) did not participate in any intervention visits, less than half (40%) participated in at least one follow-up home visit, and only 54% of sample women participated in their community's initial recipe trial. The difference in participation between women involved in the TIPs follow-up home visits and those interviewed during the endline household survey reflects the different sampling methods employed for each phase of data collection. Women who participated in intervention activities were purposively sampled during TIPs follow-up home visits to identify caregivers with divergent child feeding experiences. In contrast, all households with children 0-3 years of age were selected for sampling in treatment and control communities during the endline survey.

Table 11. Percentage of mothers attending intervention visits, reporting a willingness to adopt and reporting adoption of improved feeding practices.

intervention attendance	TIPs home visit 1 (n=52)	TIPs home visit 2 (n=41)	endline household survey (n=143)
	percent	percent	percent
participated in recipe trial	90	76	54
participated in 2 or more intervention group visits ¹	75	80	53
did not participate in any intervention activities	6	2	24
participated in at least one home visit	100	100	40
participated in both home visits	46	58	15
willingness to adopt improved IYCF practices			
willing to adopt an improved recipe and/or other improved feeding practice(or willing to continue practicing changed behaviors)	83	73	74
adoption of improved IYCF practices			
included a cereal grain (e.g. wheat, maize or barley) in the child's food on 2 or more days since the recipe trial ²	62	61	40
included a legume (e.g. pea, fava bean, <i>tarwi</i>) in the child's food on 2 or more days since the recipe trial	35	37	44
included a vegetable (primarily carrot, but also chard, tomatoes, turnip and squash ³) in the child's food on 2 or more days since the recipe trial	35	29	52
included an animal-source food (e.g. egg, meat, fish) in the child's food on 2 or more days since the recipe trial	10	12	6
included a vitamin A-fortified vegetable oil in the child's food on 2 or more days since the recipe trial	19	22	33
fed foods of improved consistency to the child (i.e. semi-solid or mashed foods to infants and young children aged 6-12 months and solid foods to children older than 8 months) on 2 or more days since the recipe trial	60	71	45
added (or continued to practice adding) at least one additional daily feeding time for the child (of solid or semi-solid foods) on 2 or more days since the recipe trial	69	78	48

prepared a toasted flour mix (to bring to pasture for feeding the child during the day) on 2 or more days since the recipe trial	35		49		43
included a legume in the toasted flour mix preparation on 2 or more days since the recipe trial	23		32		38
improved feeding practices during child illness (only mothers whose children were ill in the previous two weeks were considered ⁴)	N/A ⁵		17		20

Reporting occurred at three stages of data collection: during the first round of TIPs follow-up home visits in June/July 2009, during the second round of TIPs follow-up home visits in October 2009, and during the endline survey in March 2010.

¹ A total of four intervention group visits were conducted between June 2009 and January 2010. See **Table 1** for a description of the content of each visit.

² “Since the recipe trial” usually refers to an interval period of approximately one week between the recipe trial and the first round of TIPs follow-up home visits. The mean interval period for all communities was 6.6 days (one community where five follow-up home visits were conducted during the first round of these visits was not visited until 14 days after that community’s initial recipe trial). The recall period for questions related to improved IYCF practices during the first round of TIPs follow-up home visits was the interval period between the initial recipe trial and the home visit. However, for the second round of TIPs follow-up home visits and the endline household survey, the recall period was the previous seven days.

³ The only vegetables mentioned during the second round of TIPs follow-up home visits were carrots and chard.

⁴ During the second round of TIPs follow-up home visits 29 of 41 mothers reported that their child experienced signs of illness (e.g. diarrhea, cough, fever) in the previous two weeks. During the endline household survey 80 of 143 mothers reported that their child experienced signs of illness in the previous two weeks.

⁵ Intervention messages related to feeding during and after child illness were not promoted until after the first round of TIPs follow-up home visits.

The most commonly reported IYCF practices adopted during both TIPs follow-up home visits and the endline survey were an improved consistency of foods fed to infants and young children (i.e. semi-solid or mashed foods to infants and young children aged 6-12 months and solid foods to children older than 8 months) and an increased frequency of feeding solid or semi-solid foods (as compared to liquids and broths). Including cereal grains and legumes in children's food as well as preparing mixes of toasted flours for use in field feedings were also commonly reported. Fewer women reported including animal-source foods or vitamin A-fortified sunflower oil in children's food and less than a quarter of women interviewed during the second round of TIPs follow-up home visits and the endline household survey reported feeding more breastmilk during child illness or feeding children more often in the recovery period immediately following their illness. The percentage of women reporting select improved IYCF practices (e.g. frequency of feeding solid or semi-solids foods, improving food consistency, including cereal grains in children's food) during the endline household survey was still relatively high compared to other IYCF practices, but not as high as the percentages observed during TIPs follow-up home visits, largely due to the larger sample at endline and the inclusion of women who did not participate in any intervention visits. Even so, a large percentage of women reported including a legume and a vegetable in their children's food two or more times in the previous week (44% and 52%, respectively).

Of the 52 women interviewed during the first round of follow-up home visits, 24 were interviewed a second time during the second round of follow-up visits. Nine of sixteen of these mothers reported continuing to improve the diversity of their children's food (i.e. including a

cereal grain, legume, or vegetable in the child's food at least twice in the previous week). Of the eight women who reported not having improved the diversity of the child's diet during the first round of TIPs follow-up home visits, three reported doing so at least twice during the week prior to the second follow-up home visit interview. Five of nine women reported continuing to prepare mixes of toasted flours and three of those women reported continuing to include a toasted legume flour in those mixes. Eight women who reported not including toasted legume flours in these mixes during the first round of TIPs follow-up home visits reported doing so at least twice during the week prior to the second follow-up home visit interview.

Reported barriers to improved IYCF practices

Every mother interviewed, even those women who successfully adopted new recipes and feeding practices during the course of the intervention period, reported facing some challenges to improving their practices. In total, mothers reported 46 distinct barriers to improving IYCF practices. **Table 12** details those barriers and organizes them into 12 broad categories of obstacles. **Figure 8** shows that the most frequently reported barriers included those related to 1) limited diversity of agricultural production, 2) women's time dedicated to agricultural activities, 3) maternal self-efficacy, and 4) lack of familial support. These four barrier categories accounted for nearly one-half of all the barriers reported and the largest number of women reported facing at least one barrier from these categories than from the other barrier categories.

The two most commonly reported categories of barriers to improved IYCF practices have clear, direct linkages to agriculture. Families with a limited diversity of agricultural production reported that they were frequently unable to improve existing weaning foods and other complementary foods for infants and young children by diversifying potato-based dishes with ingredients such as cereal grains, legumes, fruits, vegetables and animal-source foods. In interviews, women also repeatedly reported the substantial burden pasturing animals placed on their daily work schedules, forcing them to condense household chores, food preparation, and child care responsibilities into the early morning and late evening hours. One woman stated, “If I didn’t have the animals, I would have more time to take care of my children. [My family] doesn't even eat meat often, so why do we keep the animals?” Another mother noted, “I spend so much time with the animals I don’t have time to make special foods for the children. I give the children whatever I cook for the whole family.

Table 12. Specific barriers and categories of barriers to improved feeding practices reported during follow-up home visits.

Category of barrier	Specific barriers reported by mothers	Nutritional and child feeding implications
limited diversity of agricultural production	families do not cultivate a large diversity of crops	the diversity of foods available to families for consumption is limited (in particular, legumes, vegetables, fruits, and for many families, cereal grains); the short supply of these foods is rationed throughout the year or saved for seed for the following sowing season
	families do not have access to their own land (many families rent land by the season by trading labor or animals in return for a portion of the harvest from the rented land; young families may only have access to the land of the husband's parents)	families may hold no control over decisions about what crops are seeded on land they work or how much is allocated to individual family members; because families do not control production decisions, they do not control the quality of foods available to the family for consumption
	families lack access to irrigation water and water for preparation of some foods (e.g. preparation of some cereal grains and legumes, notably quinoa, <i>tarwi</i> and fava beans, require relatively large amounts of fresh water for soaking); agriculture is rainfed making farmers reliant on initial spring rains to begin seeding and on increasingly unpredictable weather patterns to yield adequate harvests	food supplies from own production for family consumption are unreliable; diversifying diets with some cereal grains and legumes is difficult without the water necessary to prepare these foods
women's time dedicated to agricultural activities	women dedicate a large amount of time to pasturing animals (from early-mid morning until dusk)	all household chores, food preparation and child care activities are concentrated in the early morning and evening leaving inadequate time to appropriately feed and care for children
	mothers are fully occupied in the field tending to their animals	mothers are not able to appropriately feed and care for children that they bring with them to the fields (infants and young children are often carried on mothers' backs in a blanket throughout the day)
	infants and young children are left in the care of others throughout the day	infants and young children left in the care of a mother-in-law, older sibling or relative may receive no or inadequate breastmilk or complementary foods throughout the day and are not monitored by the mother
	mothers will stay for extended periods of time in distant grazing lands or cultivated fields	access to diverse food is more limited at these remote field sites and resources for food preparation are not as abundant (e.g. cooking fuel, utensils)
	women dedicate a large amount of time to maintaining crop cultivation, particularly during sowing and harvest times	mothers are unable to dedicate sufficient time to child care and feeding, particularly during sowing and harvest times

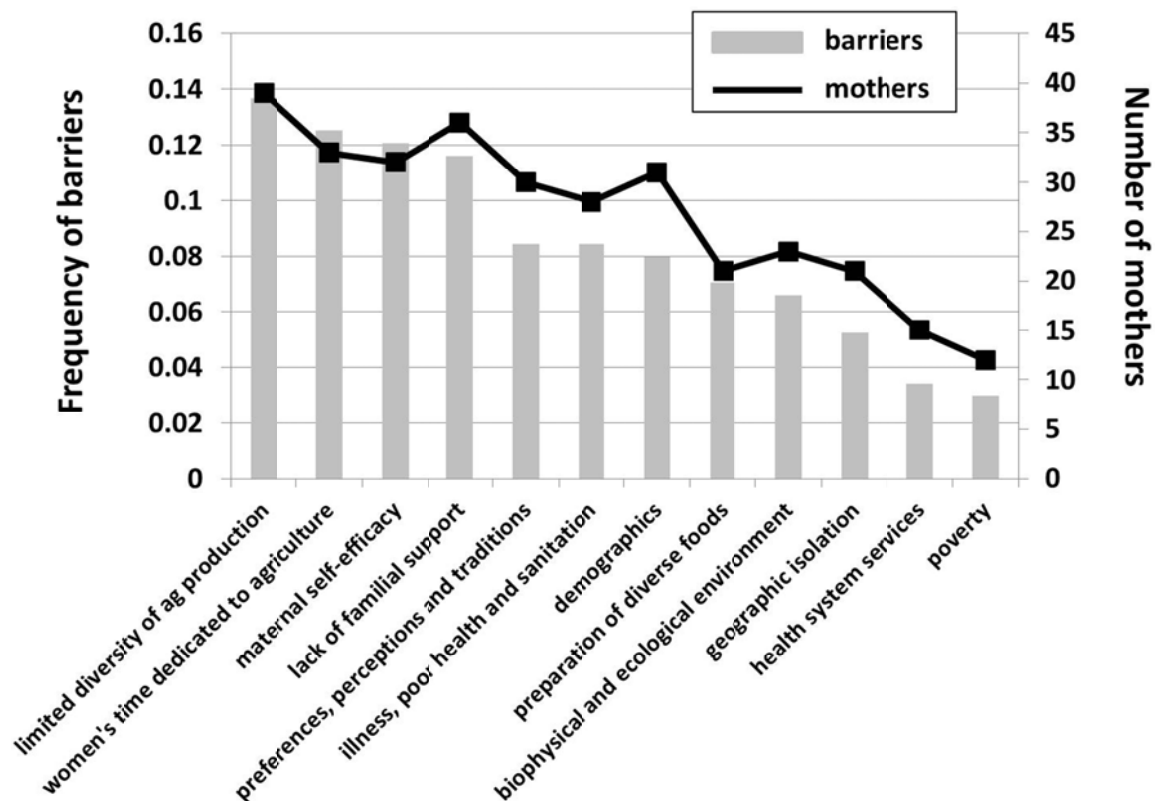
maternal self-efficacy	mothers do not retain new information and/or lack confidence in their own ability to adopt new practices	maternal infant and young child feeding practices remain unchanged without continuing education, frequent external support and encouragement to remember and put into practice new behaviors
	mothers are not motivated to improve upon existing feeding and care practices	
lack of familial support	husbands do not assist with household chores, child care responsibilities or anything perceived as “women’s work”	mothers bear responsibility for most or all household activities and therefore have less time to dedicate to any single activity, including child care and feeding
	husbands work wage labor or reciprocal labor jobs away from the community for a large portion of the year	
	husbands have abandoned the family or have passed away	
	mothers do not receive help from and are responsible for supporting aging parents or ill spouses	mothers have no control over household resources, decisions and/or face extensive emotional stress caused by physical and emotional abuse that impair their ability to function normally day-to-day
	husbands are domineering, unfaithful, disrespectful and/or abusive	
	mothers-in-law are domineering, disrespectful and/or abusive toward daughters-in-law	mothers are unable to make decisions about food preparation, meal content and child feeding and are burdened with tending to the chores and animals of their mothers-in-law; they therefore have less time to dedicate to caring for and feeding their own children
preferences, perceptions and traditions	initial weaning foods are inappropriate, contributing to monotonous, nutrient-poor diets (e.g. potatoes, <i>chuño</i> , white rice and/or noodles)	child preferences for these few, nutritionally-limited foods and aversions to other foods become embedded and are difficult to change
	food aid provided to local schools and preschool daycare programs from donors and charitable organizations consists mainly of white flour and white rice	midday meals prepared for school-aged and preschool-aged children are white flour fritters and white rice; nutrient-dense midday meals for young children are absent and child preferences for white bread and polished rice are reinforced
	potatoes and <i>chuño</i> are culturally valued and families have a difficult time regularly eating other foods; other nutritious foods such as barley are not valued and are commonly fed to the dogs	diversity of child (and adult) diets are severely limited
	mothers perceive that they have insufficient breastmilk	beliefs and perceptions lead to poor infant and young child feeding practices
	mothers believe that feeding newborns colostrum and breastfeeding children during pregnancy harm the child	
	mothers believe older children (1.5-3 years of age) do not require frequent meals and all children, regardless of age,	

	should receive the same nutritional priority	
	mothers are not convinced of the value of promoted nutrition messages	
illness and poor health and sanitation environment	children fall ill frequently (e.g. diarrhea, respiratory infections)	mothers report that children eat poorly or not at all during illness (including breastmilk)
	mothers are chronically ill from injuries (e.g. lightning strikes, falling, accidents with animals) or disease	mothers are unable to adequately perform daily responsibilities, including child feeding and care activities
	families and children are exposed to a poor health and sanitation environment (e.g. no latrine access, animals such as chickens, sheep, goats, llamas, cattle and donkeys living in close quarters with the family, exposure to untreated water and dirty environments inside structures)	children are commonly exposed to infectious agents through their daily living environment; child illness in turn has a direct impact on child dietary intake and undernutrition
household demographics	middle-aged mothers who have already raised numerous children are averse to changing feeding and care behaviors that they have practiced for many years	poor infant and young child feeding practices remain unchanged for all children
	young mothers have little to no experience raising children, often have little familial support, and/or had mistimed or unintended pregnancies and therefore have little interest in caring for a young child	infants and young children do not receive adequate care and attention
	mothers have many children and due to inadequate family planning and short birth intervals, mothers rear several infants and young children simultaneously	mothers do not have sufficient time to care for any one child; mothers face difficulty breastfeeding numerous young children and therefore some children do not receive adequate breastmilk
preparation of diverse foods	milling and peeling cereal grains (e.g. wheat, maize, barley, rye) and legumes (e.g. fava bean, pea, <i>tarwi</i>), particularly fava beans, is labor-intensive (more so than preparing potatoes)	caregivers are discouraged from incorporating foods other than potatoes, such as cereal grains and legumes, into family foods and particularly child diets
	husbands' assistance is required for milling cereal grains and legumes; this assistance is often not available or only sporadically available	
	no hand mill is available at home; families must take cereal grains and legumes to water- and industrial mills for processing, sometimes over long distances	
	soaking some cereal grains and legumes, particularly	

	quinoa and <i>tarwi</i> , as a necessary step before consumption, requires several days	
biophysical and ecological environment	harsh weather events, for example: frost, hail storms, increasingly unpredictable rains (i.e. arrival, regularity and intensity), extreme heat (lowering soil moisture)	damage to crop harvests, particularly legumes, results in reduced quantity and diversity of available food
	degrading pasture land	women forced to walk long distances from their homes to pasture their animals; higher energy expenditures and less time for child care activities
	plant diseases and pests	lower crop yields and reduced quantity and diversity of available food
	altitude and temperature	highland communities cannot grow the same diversity of crops as compared to those households at lower elevations
	cultivated fields are located quite far from homesteads	food reserves, especially of cereal grains and legumes, are stored away from the home and are brought in from field storage sites only periodically; diet diversity is thus limited in part by the frequency with which food reserves are brought home
geographic isolation	mothers must walk long distances (with children in tow) to reach health posts and hospitals (2-5 hours)	mothers do not access health services frequently (e.g. child vaccinations, health check ups, vitamin supplements, <i>Nutribébé</i> – a government-provided, fortified complementary food product)
	communities and/or homesteads are far from regional markets	limited market access results in families purchasing foods only available at markets (e.g. some fruits, vegetables, animal-source foods and cooking oils) less often; women must invest a large amount of time and energy walking to and from markets
health system services	mistreatment by health staff (e.g. discrimination against peasant mothers through refusal to treat and/or requiring such mothers to wait longer than others for treatment)	mothers do not trust or are afraid of health staff and allopathic medicine, or perceive prohibitively high barriers to accessing health services (e.g. required documents, long walking distance with possibility of no treatment) and therefore do not seek treatment or services from hospitals or health posts
	mothers associate allopathic medicine with poor health outcomes	
	health staff not reliably found at health posts and hospitals	
	lost or non-issued birth certificate or health card that health staff require for delivery of services	
	health staff provides poor information to caregivers regarding nutrition	mothers adopt poor feeding or care practices based on misinformation
poverty	families have low incomes	families are unable to purchase or trade for sufficient quantities of

		basic food commodities (e.g. oil, sugar) or other foods (e.g. fruits, vegetables, meat, eggs, cereal grains) to consume these items frequently or at all throughout the year
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Figure 8. The number of specific barriers reported from a given barrier category as a percentage of all barriers reported and the number of mothers reporting at least one barrier from the given barrier category.



Data are from interviews with 69 different women.

The long distances women walk with their animals to find adequate pasture land and the difficult physical terrain encountered were also commonly identified as barriers. One interviewee responded, “When I go with the animals, I bring a midday snack for [my child], but I usually don’t give it to her. She wants me to feed her. She won’t eat unless I feed her. When the animals are on flat ground I can feed [my child], but they’re almost always on hillsides and it’s nearly impossible to feed her there.”

A common strategy reported by women while in the pastures was to carry their young ones on their backs in a woven blanket and feed them passively by handing them whole potatoes or *chuño*. Many children, of course, are unable to handle or even chew such unwieldy foods without special assistance. One woman recognized this as a poor feeding strategy and shared the feeding approach she employs when pasturing animals. She said, “When watching the animals, I can’t feed [my child] how I like. If you don’t watch the sheep they will run off somewhere, maybe to someone else’s pasture and that shouldn’t happen. When I see the sheep are eating for a moment, I take [my child] from my back and feed her quickly until the sheep start moving again. You have to do this. Because when you’re with the animals, you can’t move about in peace.”

Gender roles and the position of women within families and the broader Bolivian society substantially contribute to the two other major barrier categories observed: maternal self-efficacy and lack of familial support. Mothers, nearly all of whom never finished primary school, often reported difficulties retaining new information and lessons learned during intervention activities, and demonstrated little confidence in their own abilities to improve infant and young child feeding and care practices. Women also reported not receiving support from spouses, relatives and in-laws for improving feeding practices; rather, quite to the contrary, many were actively discouraged from making appropriate changes to existing behaviors by abusive, domineering spouses and/or mothers-in-law who resisted acquiescing control of any household-related decisions.

Other important barrier categories reported include: 1) preferences, perceptions and traditions leading to poor quality diets, resistance to divergent perspectives, and inappropriate feeding practices, 2) illness and poor health and sanitation environment that weakened nutritional gains from improved feeding practices, 3) demographic factors related to family size and maternal experience, 4) additional time and effort required to prepare dishes other than potatoes and *chuño* including cereal grains and legumes, and 5) the biophysical and ecological environment, another barrier category directly related to agriculture that includes factors related to climate, weather, plant pests and diseases, altitude, field slopes, land quality and soil erosion.

These barrier categories were also grouped into “domains” as described previously representing common spheres of influence on women’s caregiving capacities. For example, limited diversity of agricultural production and women’s time dedicated to agricultural activities are related to the health and management of local agricultural production systems and the interaction of communities with these systems. Likewise, the biophysical and ecological environment help to determine the productivity and diversity of these systems and the time required of farmers managing them. Therefore, in analyses, the associations of these categories of barriers with improved child feeding practices were examined individually as well as collectively to reflect the fact that these categories may represent a common “domain” of barriers related to agriculture and rural livelihoods. Barriers related to maternal and child illness, the hygiene and sanitation environment of households, distrust of the health system, and obstacles to obtaining care represent variability in exposure to disease vectors,

management of illness and health-seeking behavior that are all inter-related and were considered a health and health-seeking behavior domain. Likewise, familial support, maternal self-efficacy and maternal preferences, perceptions and traditions are inter-connected and part of a common domain linked to intra-familial dynamics, shared family and cultural histories, and psycho-social conditioning influenced by family and tradition (Birch, 1999; Pelto et al, 2003).¹⁵

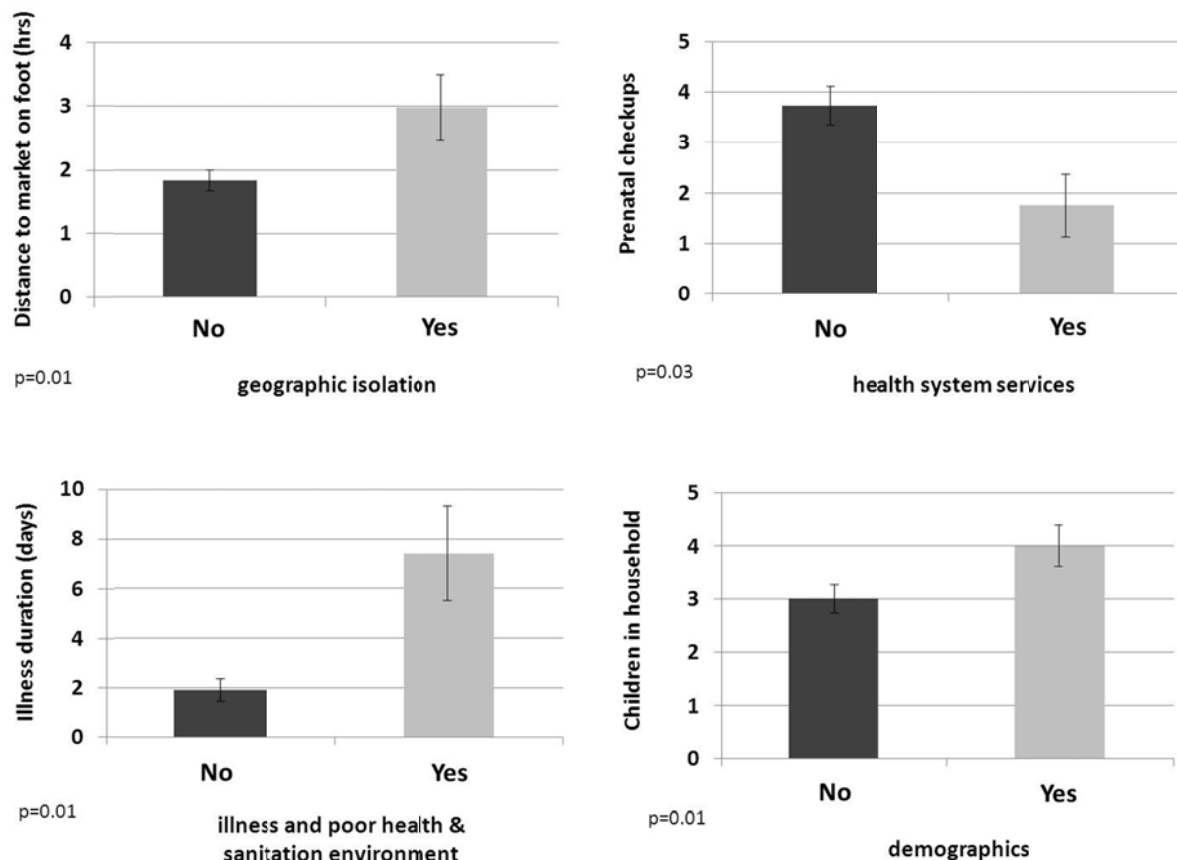
Characteristics of mothers and households reporting barriers to improved IYCF practices

The total number of reported barriers or categories of barriers to improving IYCF practices was not associated with child age, child sex, child growth, maternal age, maternal education, household food insecurity, agricultural production or animal ownership. **Figure 9**, however, shows that significant associations existed between women reporting barriers from several specific barrier categories and various child-, maternal- and household-level characteristics. For example, the mean walking distance to the nearest market for women reporting any barrier related to geographic isolation was greater than for mothers not reporting these types of barriers. Likewise, women reporting barriers to accessing health services reported attending fewer prenatal checkups and those women reporting that their children fall ill frequently or whose families are exposed to a particularly poor health and sanitation environment reported that their children experienced a longer, cumulative duration of symptoms of illness in the previous two weeks (i.e. diarrhea, cough and fever). Also, mothers who reported a large family

¹⁵ The barrier categories constituting the domains listed in the text were those established prior to analyses based on the primary researcher's (AJ) fourteen months of field experience in the region, familiarity with the dynamics of child feeding in northern Potosí, and experience analyzing qualitative interview data with caregivers, in conversational context, discussing barriers they faced to improving child feeding practices and the relations between these barriers. These barrier domains were prioritized in analyses. However, sensitivity analyses were conducted combining different categories of barriers to form distinct domains and these were also modeled.

size and/or unintended pregnancies as a challenge to improving IYCF practices on average had more children under 18 years of age in their household.

Figure 9. Mean household- and individual-level characteristics by report of barrier categories.



The mean distance to the nearest market on foot (hours), number of prenatal checkups attended during the most recent past pregnancy, cumulative duration of symptoms of illness (days) in the youngest child in the previous two weeks, and number of children <18 years of age in the household \pm SEM are shown by report of any barrier to improved IYCF practices belonging to four specific barrier categories: geographic isolation, health system services, illness and poor health and sanitation environment and demographics, respectively (n=57).

Though the total number of reported barriers or categories of barriers to improving IYCF practices was not associated with household food insecurity or household agricultural production, the “domain” of barriers related to agriculture and rural livelihoods demonstrated significant associations with these household characteristics. Again, the barrier categories constituting this domain included limited diversity of agricultural production, women’s time dedicated to agricultural activities, and the biophysical and ecological environment. **Figure 10** shows that households with women reporting a larger number of these agriculture-related barriers to improving IYCF practices seeded and harvested significantly more potato in 2009 compared to households of women reporting fewer such barriers ($p<0.1$ and $p<0.05$, respectively). Similarly, higher HFIAS scores were observed (indicating more food *insecurity*) among families reporting more such barriers compared to those reporting fewer such barriers ($p<0.1$). The production of crops other than potatoes, namely cereal grains and legumes, as well as the number of animals owned (either the total number owned or the total number of any particular animal owned) were not associated with the total number of agriculture-related barriers reported.

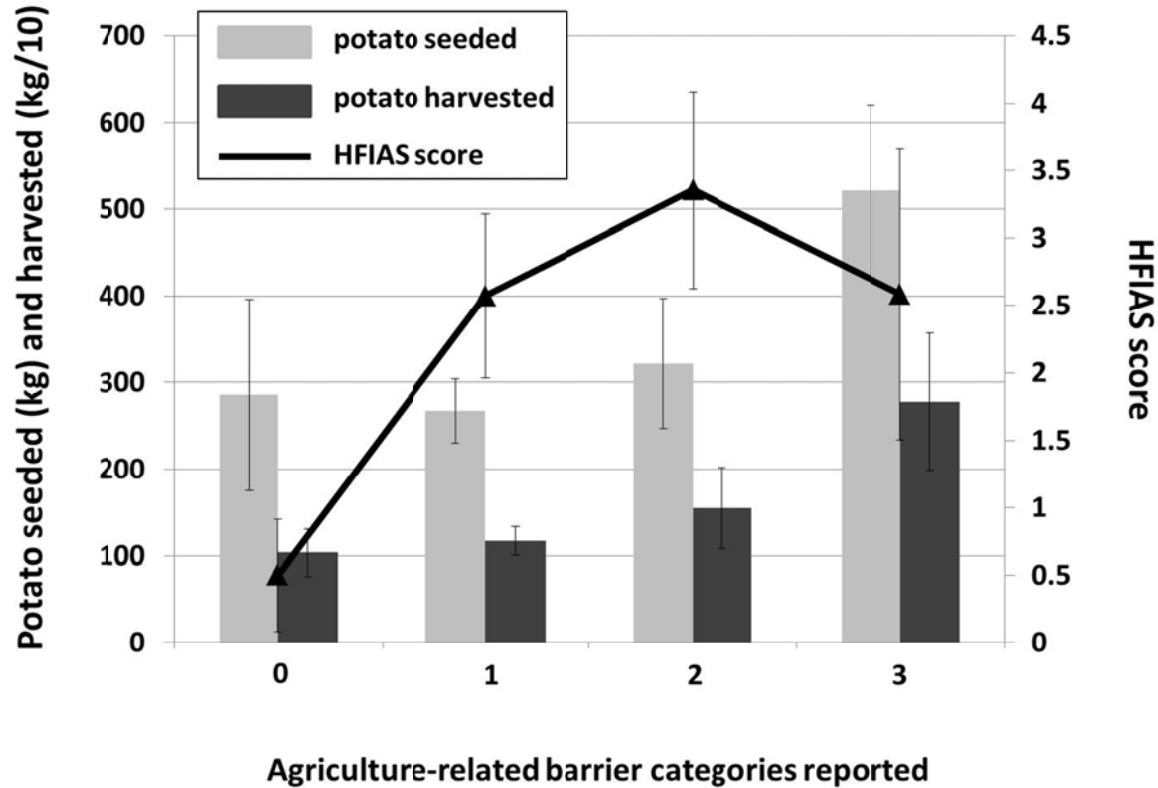
Relationship between improved IYCF practices and reported barriers to improving IYCF practices

Four indicators of improved IYCF practices were included in analyses: 1) the difference in composite ICFI score between baseline and endline, 2) the difference between baseline and endline in three individual components of the ICFI: the number of different food groups fed in the previous 24 hours, the number of different food groups fed in the previous 7 days, and the number of times solid or semi-solid foods were fed in the previous 24 hours. No single barrier

or category of barriers was significantly associated with changes in IYCF practices. Neither was the absolute number of reported barriers or categories of barriers associated with improvements to IYCF practices. Likewise, there were no associations between changes to child growth and the number of reported barriers to improving IYCF practices. In contrast, the domain of barriers related to agriculture and rural livelihoods was significantly associated with improvements to IYCF practices.

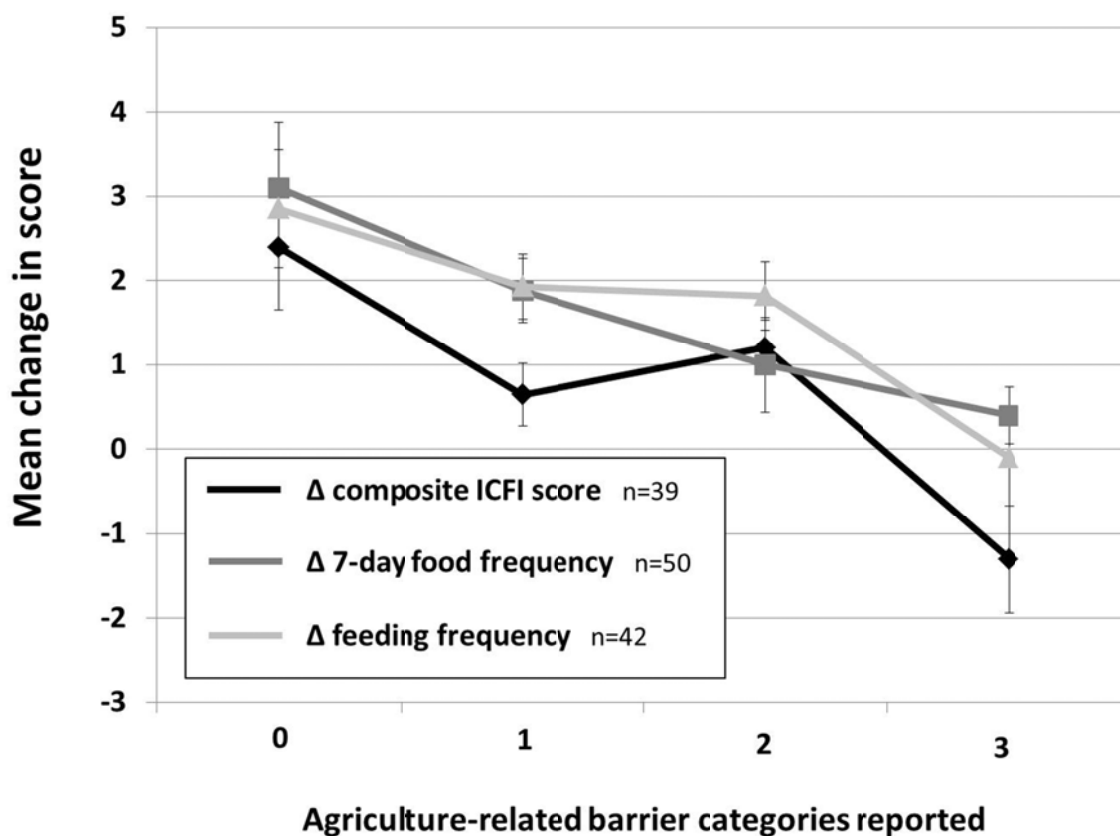
Figures 11 shows that the mean composite ICFI score between baseline and endline declined for caregivers reporting all three barriers from the domain of barriers related to agriculture while those reporting fewer showed increased scores. Likewise, families reporting more agriculture-related barriers to improving IYCF practices demonstrated less improvement in the number of different food groups fed to the child in the previous 7 days and the number of times solid or semi-solid foods were fed in the previous 24 hours as compared to families reporting fewer such barriers. Those caregivers reporting all three agriculture-related barrier categories demonstrated an average decline in ICFI score of 1.3 points, while caregivers reporting no agriculture-related barriers demonstrated an average increase of 2.4 points on the feeding index. A modest dose-response trend can be observed in the data; however, this trend was not statistically significant.

Figure 10. Mean amount of potato seeded and harvested in 2009 and endline Household Food Insecurity Access Scale (HFIAS) score by the number of agriculture-related barrier categories to improving feeding practices reported by mothers.



Means \pm SEM are shown. Categories of agriculture-related barriers include: limited diversity of agricultural production, women's roles as agriculturalists and the biophysical and ecological environment. Marginally significant differences ($p < 0.1$) were observed for potato seeded in 2009 and significant differences ($p < 0.05$) were observed for potato harvested in 2009 ($n = 59$) between mothers reporting 0 vs. 3 agriculture-related barriers. A marginally significant difference ($p < 0.1$) was observed for HFIAS score ($n = 57$) between mothers reporting 0 vs. 3 agriculture-related barriers.

Figure 11. Unadjusted mean change in feeding practices from baseline to endline by the number of agriculture-related barrier categories reported.



Means \pm SEM are shown for composite ICFI score, the number of food groups consumed by the child in the previous seven days, and the number of times solid or semi-solid foods were fed in the previous 24 hours by the number of agriculture-related barrier categories to improving IYCF practices reported by mothers. Categories of agriculture-related barriers include: limited diversity of agricultural production, women's roles as agriculturalists and aspects of the biophysical and ecological environment. Mean differences in the change in scores between mothers reporting 0 compared to 3 agriculture-related barriers were significant at $p < 0.01$.

After adjusting for the mean changes in these IYCF indicator scores from baseline to endline by baseline ICFI score, child age, sex and health status, maternal education and household socioeconomic status, the differences in the change in scores between families reporting different numbers of agriculture-related barriers to improving IYCF practices remained significant for the composite ICFI score, and the number of times solid or semi-solid foods were fed in the previous 24 hours. However, differences in the change in the number of food groups fed in the previous 7 days did not remain significant after mean adjustment.

4.4 Discussion

Improved feeding practices

The majority of women from treatment communities reported successfully improving one of more child feeding practices during the course of the agriculture-centered nutrition education intervention. These reports, collected during a large-scale household survey, were borne out in more intensive in-depth interviews conducted during follow-up visits with select caregivers who participated in intervention activities. Those feeding practices reported by caregivers as the most commonly adopted included: preparing foods of appropriate consistency for infants and young children, increasing the frequency of daily feedings, including cereal grains and/or legumes in children's meals and preparing a mix of toasted flours to feed to children while in the fields pasturing animals. Improving the diversity of child diets with animal-source foods, fruits and vegetables, and market-purchased vitamin A-fortified cooking oil as well as improving child feeding during and after illness were less commonly reported improved practices.

Barriers to improving diet diversity

The most commonly reported barrier to improving IYCF practices, limited diversity of agricultural production, may help to explain the relative difficulty caregivers faced in improving the diversity of child diets. Farmers' cropping systems in northern Potosí predominantly rotate between potato, maize and wheat at lower elevations (i.e. below 3000 meters above sea level) and potato, barley, wheat and forage oats at higher elevations (data not shown). Legumes such as fava beans, peas and Andean lupin also sometimes enter rotations. While such cropping systems may be more biodiverse and may make available a larger diversity of foods than the sole-cropped maize systems dominant throughout southern Africa (Snapp et al, 2002) or even the rice-wheat systems of South Asia (Pingali and Shah, 1999), food production is still overwhelmingly focused on a narrow range of one to two staple crops. This lack of production diversity is reflected in the potato-based diets of the families managing these systems, and in the diets of children in particular. At baseline, potatoes and other tubers contributed on average more than half (54%) of young children's daily dietary energy intake (see **Chapter 3**). Nearly all survey respondents reported that their children aged 6 months and older had consumed potatoes or cereal grains as part of their meals in the previous week, but only about half (53%) reported that legumes were consumed by the children during this same period. Vegetables, fruits and animal-source foods were even less commonly consumed.

Household food insecurity, linked in part to the diversity of production systems, almost certainly plays an additional role in preventing improvements to the diversity of child diets. Households reporting more agriculture-related barriers to improving child feeding practices

were more likely to seed and harvest a greater amount of potatoes than families reporting fewer such barriers (see **Figure 3**). This relationship, though statistically significant, is based on a small sample size (n=59) and should be interpreted cautiously. Combined with the finding though that families reporting more agriculture-related barriers to improving IYCF practices on average reported more symptoms of food insecurity, these data tend to support anecdotal evidence that potatoes serve as a “safety net” crop in northern Potosí — that is, families rely on the potato harvest above all other crops to ensure household food security throughout the year. And indeed, households maintain a minimum level of potato consumption throughout the year by increasing the consumption of *chuño*, or dehydrated potato, in the lean season to compensate for seasonal declines in fresh potato availability (Berti et al, 2010). Though those families seeding and harvesting more potato on average had more cultivated land area than other families, they also dedicated more of their total cropped land area to potatoes than to other major crops such as maize or wheat¹⁶. This may indicate a reduced willingness to accept the risk involved in the failure of other staple crops to which they could dedicate fewer resources¹⁷ and thereby may indicate a certain degree of household food insecurity which could deleteriously impact diet diversity.

The harsh physical and capricious climatic environment of northern Potosí also undermines household food security in this region of Bolivia. Erratic spring rains, destructive hail storms,

¹⁶ In the larger baseline household survey data set of 331 households, families with more total land dedicated to any crops also seeded on average more potato. However, in the smaller subsample for which data on reported barriers were available, no statistically significant relationship emerged between total land dedicated to any crops and number of agricultural-related barriers reported.

¹⁷ In general, households manage potatoes more intensively than other crops to secure more favorable yields (i.e. they apply more manure and inorganic fertilizer to their potato crop as compared to other crops). Eight-six percent of households applied

relentless winds, bitter cold and intense heat even within the same 24-hour period as well as steep and eroding cultivated mountain slopes and numerous plant pests and diseases incentivize farmers to adopt proactive risk management strategies to cope with the reliably unreliable environment and the inevitable setbacks to agricultural production it poses (e.g. by distributing risk geographically through cultivation of crops both near to homesteads and distant from communities, by investing in crops with more reliable yields such as potatoes and staple cereal grains, and by buffering crop production risk with animal rearing).

Empirical household survey data indicate, however, that though diversity of agricultural production is likely necessary to enhance the diversity of diets in northern Potosí where household food supply depends heavily upon own production¹⁸, this production diversity may not be sufficient to ensure dietary diversity. Sensitivity analyses were conducted to create “agricultural production diversity” variables using different minimum cut-off points for agricultural production based on the sampling distribution of yields for eleven different crops. However, none of these variables were significantly associated with the diversity of the household diet. Several factors may explain this lack of relationship. Household dietary diversity was calculated using a Household Dietary Diversity Score (HDDS) (Swindale and Bilinsky, 2006) that is based on 24-hour dietary recall data. These data serve only as a “snapshot” of the family’s diet and without multiple consecutive recalls, may not be representative of the usual

animal manure only to their potato crop while inorganic fertilizers, when applied, were exclusively used on potato crops (data not shown).

¹⁸ Though families do engage local markets to buy, sell and trade commodities, these exchanges merely supplement household food supplies. The majority of households’ food supplies come from their own agricultural production. The most commonly reported items purchased in the two weeks prior to the baseline survey were white rice, carrots, onions and vitamin A-fortified sunflower oil. Very few families (less than 2.5%) reported purchasing or trading for staples (i.e. potatoes, wheat, rice, maize) or legumes that dietary data indicate constitute the bulk of adult and child diets.

family diet (Gibson, 2005). Alternatively, because accurate data were not available for milk, meat or egg production, our indicator of agricultural production diversity only includes data on plant-source production, while the HDDS includes animal- and plant-source foods. Adjusting for animal ownership in analyses strengthened the relationship between production diversity and diet diversity, but the relationship remained non-significant. It is possible that incorporating more accurate data on milk, meat and egg production into an indicator of agricultural production diversity would change the observed relationship between production diversity and diet diversity. Another possible explanation is that the time of year the survey was administered may have played a role in skewing the relationship between production diversity and diet diversity. March is a transitional month between the rainy season and the beginning of the dry season in northern Potosí. Many families who normally have no access to fresh legumes, milk or dairy products are able to obtain these items at this time of year. It may be that families were consuming an unusually diverse diet at this time of year that is not representative of their usual diet and access to agricultural produce.

Aside from measurement issues that may have confounded the relationship between production diversity and diet diversity, however, families also rely upon extended family and social networks to bolster both the quantity and diversity of household food supplies. For example, certain households have relatives in nearby or distant communities that have access to a different variety of agricultural produce due to different agricultural production management strategies or their residence in a different agroecological niche. Households then

trade goods with these relatives (e.g. potatoes for maize, potatoes for legumes, wheat or barley for eggs) or accept a food offering as a gift (e.g. a household may be given a supply of dried meat after their relatives slaughter a sheep). In particular, when women marry and integrate into their husbands' families they usually preserve close ties to their own parents, thus securing a channel for resource sharing between the marriage-bonded families. These types of inter- and intra-community social networks were explicitly promoted during the intervention to strengthen the diversity and quantity of foods available to households with low agricultural production diversity and few resources.

Women's time allocation

Infant and young child feeding practices showing the most improvement following the intervention (e.g. increasing the frequency of daily feedings, preparing foods of appropriate consistency for infants and young children, changing food preparation and storage practices to make complementary foods more amenable to "field feedings") were those ostensibly more connected to women's time availability, time allocation and time use efficiency. These practices, just like diet diversity, were explicitly targeted for improvement during intervention activities. However, strategies to improve these practices were met with greater success than those aimed to improve the diversity of child diets.

Longer-term investments in physical infrastructure, education, credit access, extension services, irrigation systems and/or crop inputs are likely necessary to improve the underlying conditions in northern Potosí that contribute to poor quality diets (e.g. poor agricultural output,

productivity, and diversity, low household incomes and food insecurity). In contrast, the low-input intervention approach of this study was more conducive to changing those IYCF practices requiring fewer resources to improve by increasing knowledge, realigning caregiver priorities and increasing the efficiency of existing resource use, particularly time use.

Women in northern Potosí, not at all unlike most poor regions of the world, bear the burden of responsibility for performing many household productive activities. Numerous studies from a wide range of countries indicate that women, poor women in particular, allocate a disproportionate amount of time to domestic activities compared to men and that in most regions of the world, women spend more total time than men in agricultural, market and home production activities combined (Nag et al, 1978; Kamuzora, 1980; Caldwell et al, 1980; Acharya, 1982; King and Evenson, 1983; Bério, 1984; Mueller, 1984; Kumar and Hotchkiss, 1988; Brown and Haddad, 1995; Ilahi, 1999; Levine et al, 2001; Kes and Swaminathan, 2006). Poor women are therefore severely time-constrained. Caregivers in northern Potosí cited multiple barriers related to limited time availability that inhibited them from improving IYCF practices including: agricultural responsibilities (limited time for child care because of pasturing and crop maintenance responsibilities), lack of familial support (limited assistance and support from absentee spouses or hostile in-laws), large family sizes (many children to care for and lack of control over reproductive roles in the household), food preparation (limited time to prepare nutritious foods), geographic isolation (long distances to walk to reach markets and health services), and degrading physical environments (pasture land increasingly distant from homesteads).

Animal herding in particular emerged as an activity that consumed a disproportionate amount of women's time and energy. The mixed sheep, goat and llama herds that nearly all households manage in northern Potosí serve as a bank account for families (i.e. when in need a family can sell an animal for hard cash) and the animal excrement also provides a source of fertility for families' cultivated agricultural fields. These animal flocks then serve a crucial role in maintaining the livelihood and food security of households. They require, however, constant care throughout the year and the burden of providing this care falls primarily on women, whose cultural role it is to pasture the animals daily. Women leave their homes in the early-mid morning to guide their animals to pasture and usually return only at sundown. Rampant soil erosion, declining fodder reserves and unsustainable rangeland management practices have increased the time women spend traveling with the animals as adequate pastures are increasingly long distances from communities and often in marginal, difficult terrain. Moving to and from different pastures throughout the day, chasing straggler sheep, and negotiating difficult terrain limit women's ability to provide adequate care to young children while in the field. Young children are carried on the back and women seek brief intervals of time to breastfeed or feed the child complementary foods amidst their pasturing responsibilities. The time women dedicate to their animals, among other difficulties related to agricultural production and rural livelihoods, proved to be the crucial hurdle that they faced to improving IYCF practices.

The total number of barriers or categories of barriers related to changes in child feeding practices were not associated with improvements in IYCF practices. This is perhaps not

surprising given that women in our sample reported facing multiple, simultaneous barriers to improving child feeding practices¹⁹. One might expect that in the face of multifarious difficulties, achieving measurable progress toward improvement might not entail eliminating the largest number of obstacles, but rather alleviating that obstacle, or sphere of obstacles, offering the most resistance to change. In this context, only that sphere of influence related to agriculture and rural livelihoods emerged as significantly associated with improvements in IYCF practices. Those caregivers reporting all three of those barrier categories constituting this domain (limited diversity of agricultural production, women's time dedicated to agricultural activities, and the biophysical and ecological environment) were less likely to show improved ICFI scores following the intervention (or scores on the 7-day food group frequency and feeding frequency components of the ICFI) as compared to caregivers reporting none of these barrier categories. Women's time dedicated to agricultural activities and the limited diversity of production systems were the most commonly reported barrier categories and aspects of the biophysical and ecological environment, though less commonly reported, strengthened the association between those two barrier categories and changes in IYCF practices. Women sent a clear message in interviews that the declining quality and resiliency of local agricultural production systems, the poor return on investment in these systems (in terms of time and energy), and the unique burden they carry in sustaining these systems represent the path of greatest resistance to improving their capacities as caregivers.

¹⁹ Women on average reported 6.4 different kinds of barriers to improving child feeding practices (ranging from 1-12) from on average 4.8 different barrier categories (ranging from 1-8).

Previous research also indicates that in a diversity of settings, women's interactions with agricultural production systems and rural livelihoods may be the most significant obstacle they face to dedicating more time to child care and improving the quality of time spent providing this care.

One study of agricultural laborers in rural Tanzania found that during seasonal peaks in women's agricultural labor, women spent less time preparing food and feeding young children as compared to times of the year with less demanding agricultural work (Wandel and Holmboe-Ottesen, 1992). In general, women who spent more time in the field fed their children less frequently, and the children of mothers who brought food to the field were fed more often than those who did not. However, bringing complementary foods to the field did not predict child growth. Only the children of mothers bringing *appropriate* complementary foods to the field (i.e. higher energy density foods of appropriate consistency for young children as compared to the traditional corn on the cob that was difficult for young children to consume) showed improved growth.

A study in rural Bangladesh revealed that women engaged in agriculture were most severely time constrained during the harvest months and that of all feeding practices, feeding frequency suffered the most (i.e. women were unable to prepare cooked foods frequently throughout the day – only 1-2 times) (Levinson et al, 2002). Women also perceived child care as a duty and sacrificed their own care to minimize declines in child care during periods of intense labor. When examining data from the Ghana Living Standards Survey, Higgins and Alderman found

that women's time allocated to agricultural labor had a strong negative impact on their nutritional status and that this poor outcome for women could deleteriously affect health and nutrition outcomes of their children (Higgins and Alderman, 1993). They recommended that women's involvement in physical labor should be considered when designing and implementing rural development projects.

One incredibly detailed time allocation study of the Tamang people of northwestern Nepal (who live in the foothills of the Himalayas at altitudes analogous to those in the current study) found that the demand for women's agricultural labor was inelastic with respect to increases in child care responsibilities and the additional demands on women during pregnancy and lactation (Panter-Brick, 1989). The women in this agropastoralist society, just as in northern Potosí, are relied upon equally with men to carry out numerous agricultural production tasks throughout the year. The needs of women and children during vulnerable lifestages (i.e. pregnancy, lactation, infancy and young childhood) are subordinated to the needs of the household to sustain adequate agricultural production.

A longitudinal study of energy expenditure and physical activity levels of peasant farmers in the high Bolivian Andes (above 4,000 meters above sea level) at a site approximately 350 km southwest of the research site in this study, found high physical activity levels among men and women throughout the year and that men and women respond equitably to the increased work demands of the peak agricultural labor season (Kashiwazaki et al, 2009). However, women dedicate significantly more time than men to animal herding, an energy- and time-demanding

activity that did not fluctuate in intensity throughout the year like other agricultural responsibilities. In subsequent work in Nepal by Panter-Brick, it was similarly found that time dedicated to animal herding did not change significantly with season, but rather required a constant allocation of labor throughout the year (Panter-Brick, 1996).

Improving time allocation for child care

Despite the significant amount of time that women dedicate to animal herding and other agricultural labor throughout the year in northern Potosí, as in other low-income countries, women participating in intervention activities were commonly able to improve IYCF practices that required more time dedicated to child care and feeding. Intervention activities to enhance caregiver knowledge and expertise with improved recipes and food preparation strategies were reinforced by activities that promoted sharing agricultural responsibilities within families (e.g. involving spouses, mothers-in-law, older children during non-school days, and other appropriate relatives in the daily pasturing of animals), pooling community resources²⁰ (e.g. creating community food baskets to increase not only the entire community's access to diverse foods, but also the trading of responsibilities between families for tending to animals), shifting field feeding strategies (e.g. preparing nutrient-dense, easily-transportable complementary foods of proper consistency for feeding young children while in the field), and building broad awareness of the importance of maternal care and child nutrition and development. These activities were designed to 1) increase the total amount of time available to women for non-agricultural activities, 2) encourage them to increase the quantity and quality of time dedicated

to child care activities, and 3) make their time spent engaged in agricultural activities more conducive to proper child feeding.

Admittedly, those IYCF practices requiring relatively large investments of time to improve were not commonly reported as having changed significantly. For example, improving feeding practices during and after child illness (requiring a more concerted effort and patience on the part of the caregiver to attend to the child while ill), and frequently preparing legumes in family meals.²¹ Affording women from poor, semi-subsistence farming households a substantial amount of extra time and/or allowing them to transfer large portions of their time from agricultural and domestic responsibilities to child care activities, may require a shift in social and cultural values beyond the scope of short-term interventions. Such a shift will undoubtedly require empowering women with the knowledge, resources and support to secure their own well-being and improve their effectiveness as farmers and caregivers.

The “zero-sum game”

More than two decades ago, McGuire and Popkin introduced the notion of a “zero-sum game” for poor women in low-income countries (McGuire and Popkin, 1989). They suggest that women invest time and energy in household economic productive activities, providing care to support the health and welfare of family members, and providing for their own health and nutrition in a closed system where investment in one activity is accomplished at the expense of

²⁰ Rogers and Youssef suggest that cooperative action is important for strengthening income-earning and productive potential, fostering the exchange of knowledge and experience and facilitating flexible working conditions (Rogers and Youssef, 1988).

other activities. They write:

The challenge before individuals and institutions promoting economic development is to help women overcome resource constraints that limit their participation in the development process and stymie fulfillment of their economic, biological, and cultural roles. (McGuire and Popkin, 1989, p. 38)

Poor women today still face considerable resource constraints. Efforts to make women more productive farmers by providing them with the necessary resources such as land, agronomic inputs, credit, education and access to collectives, extension services and support networks can lead to improved yields, higher incomes and better time-use efficiency for women. These same efforts can simultaneously contribute to positive nutrition outcomes for the mother and child. Engle and others identify a set of resources required to support the provision of adequate care both to mothers and children. These resources markedly resemble that list of resources required to improve women's farming productivity. They include: caregiver education, knowledge and beliefs, caregiver physical health and nutritional status, caregiver mental health and self-confidence, autonomy and control of resources, workload and time availability, and family and community social support (Engle et al, 1996). Improving a woman's education, increasing her control over household resources and decisions, strengthening her support networks, reducing her workload and increasing her time dedicated to her own care and that of her young ones are common areas of intervention that can have potential positive impacts both on a woman's agricultural productivity and the fulfillment of her role as a caregiver.

²¹ Though caregivers did report improving this practice, they did not do so to the extent as those more commonly-reported improved practices. One component of this is the lack of consistent availability of legumes, but another component is the extra

Targeting interventions to exclusively involve women, however, would be a mistake. Men have a vested interest both in increasing the agricultural productivity of their family farm (to secure the economic welfare of their household) and in contributing to the proper care of their children (to secure their healthy growth and development and ensure that they will contribute labor and income to the household in the future). However, culturally ingrained attitudes toward women, gender divisions of labor, poverty conditions and lack of education and awareness may prevent men from supporting the women in their lives who are critical to securing these interests. The intervention program described in this study largely failed to involve men in group discussions during community visits. Though invited, when community meetings began to be seen as gatherings of women to discuss child care issues, men became disinterested. For many of them, the subject did not seem relevant to the daily livelihood difficulties they faced. Future programmatic work must be smarter in its attempts to “sell” communities, men in particular, on the importance of proper maternal and child care by linking these outcomes to shared goals, values and priorities (e.g. securing a consistent, adequate income, maintaining a productive farm, feeling self-respect and pride in one’s life and livelihood, and raising a healthy family). Social marketing strategies might be employed to make explicit to men and women the linkages between women’s agricultural labor, their health and nutrition, the health and nutrition of young children, and the long-term impacts of undernutrition not only on children, but on the entire household (see **Figure 1** for more information on these pathways).

time required to soak and prepare the legumes for consumption.

A positive-sum game for women in northern Potosí can be achieved in part through women's increased productivity, control of income, and access to health services (McGuire and Popkin, 1989). Efficiency gains alone will not likely be sufficient, however. Substantial evidence suggests that while poor women's time saved through labor-saving or productivity-enhancing agricultural technologies may be reallocated to child care activities, it is likely to be invested in domestic chores, or even other types of agricultural labor or income-generating activities (FAO, 1977; Carr, 1978; Bleiberg et al, 1980; Holmboe-Ottesen et al, 1988; Malmberg-Calvo 1994; Blackden 2002). Therefore, an intervention introducing a technology that decreases a woman's time required for weeding, for example, may only succeed in increasing the time she spends collecting water, firewood, making handicrafts for sale in the market, or planting additional crops if efforts are not made to purposefully guide time use decisions toward child care and/or maternal care. The tenuous foundation of support offered to women by spouses and in-laws in northern Potosí makes time gains fragile and perhaps unsustainable without fundamental shifts in the support structures and gender roles within which women's work is embedded. Women in intervention communities were able to dedicate more time to child feeding ostensibly by making small changes in the kinds of recipes prepared for young children and in their time allocated to child feeding during and outside of agricultural activities, particularly animal pasturing. Follow-up research is required though to understand if these changes are sustainable, and how differing strengths of familial and social support structures interact to reinforce or prevent sustainable time use changes by women.²²

²² Men in a small number of households where caregivers were interviewed during follow-up home visits (13 of 69), did indeed

Further research and program work should also combine both short and long route approaches to confronting the multiple barriers women face to improving infant and young child feeding and care practices.²³ The intervention program in this study relied largely on short route solutions, focused on minor shifts in feeding practices and time allocation behaviors. However, these gains should be complemented by longer-term strategies to rehabilitate local rangelands, improve the diversity and productivity of farming systems, increase the quality of and access to health services, and enhance educational opportunities for girls and women. Evidence- and experience-based intervention programs can begin addressing many of these deficits immediately. At the same time, further research studies, driven by community input and participation, are urgently needed to inform such programs by identifying the most cost-effective and accepted combinations of short- and long-route approaches that empower women as agropastoralists, caregivers, and individuals and ultimately lead to the improved health, nutrition and well-being of children and families.

share some of the responsibility with women for household chores and child care (as reported by women interviewed or the men themselves if present during the interview).

²³ The language of “short routes” and “long routes” is borrowed from the World Bank in the context of short- and long-route strategies to improving nutrition (World Bank, 2006). Short routes are those more direct approaches that can yield results relatively quickly (e.g. community-based nutrition and health services, micronutrient supplementation, hygiene education) and long routes being those approaches that require more time to mature and are perhaps less direct solutions (e.g. improving primary health care, employment creation, increasing women’s education).

References

- Acharya M. Time use data and the living standard measurement study. Living Standard Measurement Series Working Paper no. 18. Washington, DC: World Bank, 1982.
- Arimond M, Ruel MT. Progress in developing an infant and child feeding index: an example using the Ethiopia Demographic and Health Survey 2000. FCND discussion paper no. 143. Washington, DC: IFPRI, 2002.
- Arimond M, Hawkes C, Ruel MT, Sifri Z, Berti PR, Leroy JL, Low JW, Brown LR, Frongillo EA. Agricultural Interventions and Nutrition: Lessons from the Past and New Evidence. In: Combating Micronutrient Deficiencies: Food-Based Approaches. (Thompson B, Amoroso L, eds.), pp. 41-75. Rome, Italy: Food and Agriculture Organization of the United Nations, 2010.
- Asociación de Municipios del Cono Sur (AMDECO). Comunidades por Cantón y Sub Centrales: Elaboración Propia. Cochabamba, Bolivia: Asociación de Municipios del Cono Sur, 2009.
- Bério AJ. The analysis of time allocation and activity patterns in nutrition and rural development planning. Food and Nutrition Bulletin 1984;6(1):53-68.
- Berti PR, Krusevec J, Fitzgerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. Public Health Nutrition 2004;7:599-609.
- Berti PR, Jones AD, Cruz Y, Larrea S, Borja R, Sherwood S. Assessment and characterization of the diet of an isolated population in the Bolivian Andes. American Journal of Human Biology 2010;22:741-749.
- Birch LL. Development of food preferences. Annual Review of Nutrition 1999;19:41-62.
- Blackden CM. All Work and No Time: Time Poverty as a Development Issue in Africa. Poverty Reduction and Economic Management, Africa Region, The World Bank. Washington, DC: The World Bank, 2002.
- Bleiberg F, Brun TA, Goihman S, Gouba E. Duration of activities and energy expenditure of female farmers in dry and rainy seasons in Upper Volta. Brit J Nutr 1980;43:71-82.
- Brown LR, Haddad L. Time Allocation Patterns and Time Burdens: A Gendered Analysis of Seven Countries. Washington, DC: International Food Policy Research Institute, 1995.

Caldwell JC, Jalaluddin AKM, Caldwell P. Cosford W. The control of activity in Bangladesh. Working Papers in Demography, 12. Canberra: Department of Demography, Research School of Social Sciences, Australian National University, 1980.

Carr M. Appropriate technology for African women. Addis Ababa, Ethiopia: African Training and Research Centre for Women, UN Economic Commission for Africa, 1978.

Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide version 3. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.

Comité Técnico del Consejo Nacional de Alimentación y Nutrición. Desnutrición Cero al 2010: compromiso multisectorial (Primera Aproximación). La Paz, Bolivia: Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006.

Cramer LK, Wandira SK. Strengthening the Role of Women in the Food Systems of Sub-Saharan Africa to Achieve Nutrition and Health Goals. In: The African Food System and Its Interaction with Human Health and Nutrition (Pinstrup-Andersen P, ed.), pp. 261-278. Ithaca, NY: Cornell University Press in cooperation with United Nations University, 2010.

Cruz Y, Jones AD, Berti PR. Prácticas de Lactancia Materna, Alimentación Complementaria y Cuidados del Infante en el Norte de Potosí – Bolivia. Archivos Latinoamericanos de Nutrición 2010;60(1):7-14.

Dao MQ. Rural poverty in developing countries: An empirical analysis. Journal of Economic Studies 2004;31(6):500-508.

Dickin K, Griffiths M, Piwoz E. Designing by Dialogue: A Program Planners' Guide to Consultative Research for Improving Young Child Feeding. Prepared for the Health and Human Resources Analysis (HHRAA) Project, 1997.

Doss C. The Effects of Women's Bargaining Power in Household Health and Education Outcomes: Evidence from Ghana. Mimeograph. Williamstown, Massachusetts: Williams College, 1997.

Engle PL. Childcare and nutrition. Theme Paper for the International Conference on Nutrition. New York: UNICEF, 1992.

Engle PL, Menon P, Haddad L. Care and Nutrition: Concepts and Measurement. Food Consumption and Nutrition Division, Discussion Paper 18. Washington, DC: International Food Policy Research Institute, 1996.

Food and Agriculture Organization of the United Nations. Women in food production, food handling and nutrition. A report of the Protein-Calorie Advisory Group of the United Nations System. FAO Food and Nutrition paper. Rome: FAO, 1977.

Food and Agriculture Organization of the United Nations. The State of Food and Agriculture: Women in Agriculture: Closing the gender gap for development. Rome, Italy: FAO, 2011.

Frongillo EA, Nanama S. Development and Validation of an Experience-Based Measure of Household Food Insecurity within and across Seasons in Northern Burkina Faso. *J Nutr* 2006;136:1409S-1419S.

Gibson RS. Principles of nutritional assessment. New York: Oxford University Press, 2005.

Glaser BG, Strauss AL. Discovery of Grounded Theory: Strategies for Qualitative Research. Chicago: Aldine Publications, 1967.

González W, Jiménez A, Madrigal G, Muñoz LM, Frongillo EA. Development and Validation of Measure of Household Food Insecurity in Urban Costa Rica Confirms Proposed Generic Questionnaire. *J Nutr* 2008;138:587-592.

Higgins PA, Alderman H. Labor and Women's Nutrition: A Study of Energy Expenditure, Fertility, and Nutritional Status in Ghana. Cornell Food and Nutrition Policy Program Working Paper. Washington, DC: CFNPP Publications, 1993.

Hoddinott J, Haddad L. Women's Income and Boy-Girl Anthropometric Status in the Côte d'Ivoire. *World Development* 1994;22(4):543-53.

Holmboe-Ottesen G, Mascarenhas O, Wandel M. Women's role in food production and nutrition: Implications for their quality of life. *Food and Nutrition Bulletin* 1988;10(3):8-15.

Ilahi N. Gender and the Allocation of Adult Time: Evidence from the Peru LSMS Panel Data. Washington, DC: The World Bank, 1999.

Instituto Nacional de Estadística. Ministerio de Hacienda. Gobierno de Bolivia. La Paz, Bolivia, 2004. [online]. Available at <http://static-200-105-141-238.accelerate.net/geoclip/launchmap.php>. Accessed 18 October 2010.

International Food Policy Research Institute. Green Revolution: Curse or Blessing? Washington, DC: IFPRI, 2002.

Kamuzora CL. Constraints to labour time availability in African smallholder agriculture: the case of Bukoba District, Tanzania. *Dev Change* 1980;11:123-35.

Kashiwazaki H, Uenishi K, Kobayashi T, Rivera JO, Coward WA, Wright A. Year-Round High Physical Activity Levels in Agropastoralists of Bolivian Andes: Results from Repeated Measurements of DLW Method in Peak and Slack Seasons of Agricultural Activities. *American Journal of Human Biology* 2009;21: 337-345.

Katz E. The Impact of Non-traditional Export Agriculture on Income and Food Availability in Guatemala: An Intrahousehold Perspective. *Food and Nutrition Bulletin* 1994;15(4).

Kendall A, Olson CM, Frongillo EA, Kepple A. Validation of the Radimer/Cornell measures of hunger and food insecurity. *J Nutr* 1995;125:2793-801.

Kennedy ET, Cogill B. Income and Nutritional Effects of the Commercialization of Agriculture in Southwestern Kenya. Research Report 63. Washington, DC: International Food Policy Research Institute, 1987.

Kes A, Swaminathan H. Gender and Time Poverty in Sub-Saharan Africa. In: *Gender, Time Use, and Poverty in Sub-Saharan Africa* (Blackden CM, Wodon Q, eds.), pp. 13-38. World Bank Working Paper No. 73. Washington, DC: The World Bank, 2006.

King E, Evenson RE. Time allocation and home production in Philippine rural households. In: *Women and poverty in the third world*. (Buvinic M, Lycette MA, and McGreevey WP, eds.). Baltimore, MD, USA: Johns Hopkins University Press, 1983.

Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. *Bulletin of the World Health Organization* 1987;65(5) 663–737.

Kumar SK, Hotchkiss D. Consequences of Deforestation for Women's Time Allocation, Agricultural Production, and Nutrition in Hill Areas of Nepal. Research Report 69. Washington, DC: International Food Policy Research Institute, 1988.

Kurth A. Agricultural development and nutritional status in Malawi. *Journal of Tropical Pediatrics* 1989;35: 250-4.

Levine JA, Weisell R, Chevassus S, Martinez CD, Burlingame B, Coward WA. The work burden of women. *Science* 2001;294:812.

Levinson M, Halpern O, Mahmud Z, Chowdhury SA, Levinson FJ. Nutrition-related Caring Practices and Women's Time Constraints: A Study in Rural Bangladesh. Tufts University Food Policy and Applied Nutrition Program, Discussion Paper No. 18. Boston, MA: Friedman School of Nutrition Science and Policy, 2002.

Lunch N, Lunch C. *Insights into Participatory Video: A Handbook for the Field*. Oxford, UK: Insight, 2006.

Malmberg-Calvo C. Case Study on the Role of Women in Rural Transport: Access of Women to Domestic Facilities. Sub-Saharan Africa Transport Policy Program, World Bank and Economic Commission for Africa Working Paper No. 11. Environmentally Sustainable Development Division, Technical Department, Africa Region, The World Bank. Washington, DC: The World Bank, 1994.

Marsh DR, Schroeder DG, Dearden KA, Sternin J, Sternin M. The power of positive deviance. *British Medical Journal* 2004;329(7475):1177-1179.

McGuire J, Popkin BM. Beating the Zero Sum Game: Women and Nutrition in the Third World. Part 1. *Food and Nutrition Bulletin* 1989;11(4):38-63.

Moursi MM, Martin-Prével, Eymard-Duvernay S, Capon G, Trèche S, Maire B, Delpuech F. Assessment of child feeding practices using a summary index: stability over time and association with child growth in urban Madagascar. *Am J Clin Nutr* 2008;87:1472-9.

Mueller E. The value and allocation of time in rural Botswana. *J Dev Econ* 1984;15(1-3):329-60.

Nag M, White BNF, Peet RC. An anthropological approach to the study of the economic value of children in Java and Nepal. *Curr Anthropol* 1978;19(2):293-306.

Nielsen H, Roos N, Thilsted SH. The Impact of Semi-Scavenging Poultry Production on the Consumption of Animal Source Foods by Women and Girls in Bangladesh. *Journal of Nutrition* 2003;133: 4027S-30S.

Niemeijer R, Geuns M, Kliet T, Ogonda V, Hoorweg J. Nutrition in agriculture development: the case of irrigated rice cultivation. *Ecology of Food Nutr* 1988;22:65-81.

Pachón H, Reynoso MT. Improving Infant and Child Nutrition in El Alto, Bolivia: Results Using the *ProPAN* Methodology. Lutter C, del Carmen Daroca M, León-Cava N, eds. Washington, DC: PAHO, 2002.

Pan American Health Organization. *ProPAN: Process for the Promotion of Child Feeding*. Washington, DC: Pan American Health Organization, 2004.

Panter-Brick C. Motherhood and Subsistence Work: The Tamang of Rural Nepal. *Human Ecology* 1989;17(2):205-228.

Panter-Brick C. Seasonal and sex variation in physical activity levels among agro-pastoralists in Nepal. *Am J Phys Anthropol* 1996;100:7–21.

Patton MQ. *Qualitative Research & Evaluation Methods*. 3rd ed. Thousand Oaks, CA: Sage Publications, 2002.

Pelto GH, Levitt E, Thairu L. Improving feeding practices: Current patterns, common constraints, and the design of interventions. *Food Nutr Bull* 2003;24(1):45-82.

Peterman A, Quisumbing A, Behrman J. Review of empirical evidence on gender differences in non-land agricultural inputs, technology, and services in developing countries. Background paper prepared for *The State of Food and Agriculture 2010–11*. Rome, FAO, 2010.

Pingali PL, Shah M. Rice-Wheat Cropping Systems in the Indo-Gangetic Plains: Policy Re-directions for Sustainable Resource Use. In: *Sustaining rice-wheat production systems: socio-economic and policy issues: Rice Wheat Consortium Paper Series 5*. (Pingali PL, ed.), pp. 1-12. New Delhi, India: Rice-Wheat Consortium for the Indo-Gangetic Plains, 1999.

Pinstrup-Andersen P. *Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches*. World Bank. Washington DC. 1981.

Quisumbing A, Brown L, Feldstein H, Haddad L, Peña C. *Women: The Key to Food Security*. Food Policy Report. Washington, DC: International Food Policy Research Institute, 1995.

Quisumbing AR. Male–female differences in agricultural productivity: methodological issues and empirical evidence. *World Development* 1996;24(10):1579–1595.

Quisumbing A, Brown L, Haddad L, Meinzen-Dick R. Gender issues for food security in developing countries: implications for project design and implementation. *Canadian Journal of Development Studies* 1998;19:185–208.

Quisumbing AR, Pandolfelli L. Promising Approaches to Address the Needs of Poor Female Farmers: Resources, Constraints, and Interventions. *World Development* 2010;38(4):581–592.

Rasmussen KM. The Influence of Maternal Nutrition on Lactation. *Annual Review of Nutrition* 1992;12:103-17.

Rogers BL, Youssef N. The importance of women’s involvement in economic activities in the improvement of child nutrition and health. *Food and Nutrition Bulletin* 1988;10(3):33-41.

Rogers BL, Swindale A, Ohri-Vachaspati P. Determinants of Household Food Security in Honduras. Bedford, Massachusetts: Tufts University Department of Nutrition, 1996.

Roos N, Islam MM, Thilsted SH. Small Indigenous Fish Species in Bangladesh: Contribution to Vitamin A, Calcium and Iron Intakes. *Journal of Nutrition* 2003;133: 4021S–26S.

Snapp SS, Rohrbach DD, Simtowe F, Freeman HA. Sustainable soil management options for Malawi: can smallholder farmers grow more legumes? *Agriculture, Ecosystems and Environment* 2002;91:159–174.

Strauss A, Corbin J. Basics of Qualitative Research: Techniques and Procedures for Developing Ground Theory. 2nd ed. Thousand Oaks, CA: Sage Publications, 1998.

Swindale A, Bilinsky P. Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (Version 2). Food and Nutrition Technical Assistance Project (FANTA). Washington, DC: Academy for Educational Development, 2006.

Udry C, Hoddinott J, Alderman H, Haddad L. Gender differentials in farm productivity: implications for household efficiency and agricultural policy. *Food Policy* 1995;20(5):407-423.

UNICEF. Strategy for Improved Nutrition of Children and Women in Developing Countries. United Nations Children’s Fund, 1990.

Vanek S. Soil gradients and legumes in mountain agroecosystems: N and P cycling and legume functional attributes in the Bolivian Andes. Doctoral dissertation. Cornell University, Ithaca, NY, 2010.

Wandel M, Holmboe-Ottesen G. Women's Work in Agriculture and Child Nutrition in Tanzania. *J Trop Pediatr* 1992;38(5):252-255.

Webb AL, Stein AD, Ramakrishnan U, Hertzberg VS, Urizar M, Martorell R. A simple index to measure hygiene behaviours. *International Journal of Epidemiology* 2006;35:1469–1477.

Ward-Batts J. Out of the Wallet and Into the Purse: Does Income Control Really Affect Intrahousehold Resource Allocation? Seattle: University of Washington, 1996.

Wishik SM, Van der Vynckt S. The use of nutritional "positive deviants" to identify approaches for modification of dietary practices. *Am J Public Health* 1976;66(1):38-42.

World Bank. Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action. Washington, DC: The World Bank, 2006.

World Bank. From Agriculture to Nutrition: Pathways, Synergies, and Outcomes. Agriculture and Rural Development Department. Washington, DC: World Bank, 2007.

Wu G, Bazer FW, Cudd TA, Meininger CJ, Spencer TE. Maternal Nutrition and Fetal Development. *Journal of Nutrition* 2004;134:2169-2172.

5. Mothers' scores on an infant and child feeding index show improvement following an agriculture-centered nutrition education intervention in the Bolivian Andes

5.1 Introduction

Chapter 3 first introduced the concept of an infant and child feeding index (ICFI) as a tool for assessing caregivers' feeding practices and the quality of young child diets. The ICFI is a summary indicator that combines information on breastfeeding and bottlefeeding practices, the diversity of child diets and the frequency of feeding of young children into a single, age-specific measure. Several authors have used variations of a composite ICFI in different settings to explore associations between the index and child growth (Ruel et al, 1999; Ruel and Menon, 2002; Arimond and Ruel, 2002; Ntab et al, 2005; Lai et al, 2005; Sawadogo et al, 2006; Becquet et al, 2006; Srivastava and Sandhu, 2007; Moursi et al, 2008; Moursi et al, 2009; Zhang et al, 2009; Wang et al, 2009; Garg and Chadha, 2009). Results from these studies are mixed, but generally show that in multivariate analyses controlling for various child, maternal and household level variables, the ICFI is positively associated with child height-for-age Z-score (HAZ) when using large data sets (i.e. $n \sim > 1000$) from rural populations (see **Chapter 3**). However, the authors are unaware of any attempts to use the ICFI as a tool for program evaluation.

One study in Madagascar examined the stability of ICFI scores at three different time points in the absence of any intervention in a population of urban children aged 6-17 months (Moursi et al, 2008). The study found that the ICFI was indeed stable over time. As children aged, lower

scores on the breastfeeding component of the ICFI (due to mothers terminating breastfeeding) were compensated for by increases in feeding frequency and higher diet diversity, two other components of the ICFI. These authors were not, however, interested in using the ICFI to evaluate changes in feeding practices over time resulting from an intervention. Authors of a different study carried out an exercise simulating moderate to strong changes in individual ICFI components to determine changes in a composite ICFI that could potentially result from programmatic interventions (Arimond and Ruel, 2002). They found that the percentage change in the composite ICFI score compared to baseline levels accurately reflected an averaging of the changes in individual practices. These authors conclude that the ICFI may be a useful tool for program evaluation if 1) programs are designed to change most or all ICFI component practices, 2) the program seeks to evaluate overall progress toward improving feeding practices, and 3) baseline levels of component practices do not differ between comparison areas.

The present study examines changes in IYCF practices using an ICFI as an evaluation tool in the context of a small-scale, community-based program in rural Bolivia. Analyses are constructed comparing baseline and endline data, collected one year apart, from an eight-month, agriculture-centered nutrition education and growth monitoring intervention program that recruited children from birth to 36 months of age. The program targeted multiple IYCF practices, including all of those measured by the ICFI, and sought to evaluate caregivers' progress toward achieving broad improvements in their feeding practices. This study aims to determine 1) changes in the composite scores and individual component scores of an ICFI resulting from the nutrition intervention, and 2) changes in feeding practices as measured by

select WHO IYCF indicators, in particular the “minimum acceptable diet” summary indicator.

5.2 Subjects & Methods

Data collection & sampling

The research was conducted in collaboration with the non-governmental organization (NGO), World Neighbors – Bolivia (WNB). Though historically focused on sustainable agriculture and family planning programming, in 2005 WNB began collecting child anthropometric and household dietary data as well as ethnographic data on IYCF practices in northern Potosí to lay the foundation for future activities aimed at improving maternal and child nutrition. In March 2009, an initial household survey was conducted to expand upon this formative research and establish a baseline from which intervention activities could be evaluated. A description of the methods used to conduct this survey as well as the endline survey that was conducted one year later is provided in **Chapter 3**.

Treatment group assignment

Chapter 4 discusses the process used to assign communities to treatment groups. Thirty-one communities were assigned to the control group and 13 communities to the treatment group.

Introductory meetings were scheduled with the 13 communities conditionally assigned to the “treatment” group to discuss their participation in an eight-month, agriculture-centered nutrition intervention. Community meetings in this region of Bolivia are quite participatory with

every community member given the opportunity to express his or her viewpoint on pending decisions. Power dynamics in most communities, however, often preclude women from speaking their voice and ultimately, the male authorities in the community (assigned to authority positions on a rotating basis) have the final say on all issues. Two communities, the same communities that refused participation in the endline survey, declined the offer to participate in the nutrition intervention despite the objections from mothers in the community who were eager to participate in both the intervention and survey. Authorities in these communities declined participation for one primary reason. Prior to the baseline survey, WNB hired a new director, new office staff and overhauled its perspective on development work. The organization eschewed its previous top-down, input-heavy approach to community development and instead adopted a strategy based on community-centered capacity building with little to no external, physical inputs. Authority figures in both communities that declined participation were former employees of WNB and were opposed to this new approach by the organization. Members of these same communities also began to actively work against WNB later that year in protest of the organization's action to let the contracts of its salaried field promoters expire. WNB now sought to work with community volunteers instead of paid field staff. This shift in strategy was not well received by many male members of these communities. Likewise, in the months following the start of the nutrition intervention, even communities that agreed to participate in the intervention expressed concerns that capacity building activities were sufficient and began to lobby WNB to supply the communities with food stuffs, seed, animals and improvements to physical infrastructure. These concerns were not surprising given most communities' decades-long exposure to the scores of NGOs that operate in the region

largely through investments in physical inputs to communities. Interestingly, those communities with relatively less exposure to NGOs (because of their physical isolation) expressed little resistance to WNB's grassroots, capacity-building approach.

Two alternative communities were invited to participate after two of the 13 initial communities declined participation. These alternative communities accepted and 13 remained the total number of initial treatment communities. All participating communities agreed to work to improve child nutrition in collaboration with WNB using only existing community resources. However, after three months, one community dropped out of the intervention because WNB was not freely providing chickens, seed or cash transfers.

Intervention activities & messages

The nutrition intervention was conducted as a pilot program in a relatively small number of initial communities. Based on its impact, regional Ministry of Health offices were to scale up the intervention and incorporate it into their ongoing, monthly community visits. At the time of this research, these visits included little to no emphasis on maternal and child nutrition.

The research team planned to visit each community six times from June 2009 to January 2010 to implement an agriculture-centered nutrition education intervention focused on improving IYCF practices using locally-available resources, in particular, community agrobiodiversity, women's abilities as farmers and herders, intra- and inter-community social networks, and women's considerable existing knowledge of agriculture, food preparation, child feeding and

the connections between them. Each phase of the intervention was purposefully designed to 1) strengthen the capacity of caregivers to adequately feed their infants and young children and 2) enable the research team to learn about and collect data on local IYCF practices, barriers to improving them and the complex role agriculture in influencing these practices. Previous research in an urban region of Bolivia, employing methods similar to those used in this study, demonstrated that IYCF practices could be improved using only local resources (Pachón and Reynoso, 2002).

The core of the intervention emphasized a modified, consultative research methodology known as Trials of Improved Practices (TIPs) (Dickin et al, 1997). This research method employs interactive information-gathering and feedback sessions with mothers and program beneficiaries to identify feasible, acceptable, and effective strategies to improve nutrition-related behaviors (Dickin et al, 1997). Normally, this method is used as a tool for formative research, however, in this context the research team employed it not only as a research tool, but also as an intervention mechanism to 1) strengthen caregivers' abilities to adopt new recipes, IYCF practices and agricultural practices by engaging them directly in the shaping of those recipes and improved practices and 2) creating spaces for caregiver-led, individual and group feedback sessions to adapt improved practices based on emerging needs and lessons learned.

Five feeding messages, based on formative research (Berti et al, 2010; Cruz et al, 2010) that identified the most critical gaps in child diets and IYCF practices, were promoted throughout

the intervention. These included: 1) improving the diversity of child diets, 2) improving the energy density of complementary foods, 3) increasing the frequency of daily feedings, 4) feeding appropriately during and after illness (i.e. increasing fluid intake, including breastmilk, and maintaining an adequate diet during illness; feeding more often after illness), and 5) exclusively breastfeeding to six months of age and maintaining frequent breastfeeding until two years of age. Based on these messages and the expressed priorities of caregivers during community recipe trials, households experimented with adopting new feeding practices, changing caregivers' routines as agriculturalists (i.e. farmers and herders), strengthening social networks, pooling community resources (e.g. crop biodiversity and labor), changing cropping patterns, and adapting traditional recipes using locally-available foods to create improved complementary food recipes for infants and young children.

In northern Potosí, meals are traditionally prepared in a common pot for the entire family and everyone is served from that pot. Children are not usually an exception to this practice. They receive the same foods as adults only in smaller portions. Though specific improved recipes developed during recipe trials varied by community, common preparation strategies emerged across communities and many of these focused on viewing the child and his or her plate as unique and requiring special attention. Some of these strategies included: 1) diversifying family meals by including a cereal grain (e.g. wheat, maize, or barley) and when possible a legume (e.g. fava bean, pea, common bean or Andean lupin - *Lupinus mutabilis*) to potato-based dishes, 2) purposefully selecting ingredients from the common family pot to ensure the child receives a diversity of foods on his/her plate, 3) cutting carrots and other commonly-used vegetables in

larger “chunks” (instead of finely shredded pieces) and serving one or more of those “chunks” to the child, 4) increasing the energy and nutrient density of the child’s meal by draining excess water from the child’s dish before serving, 5) mashing foods into a purée to make them easier for the child to consume, and 6) adding a spoonful of oil to the child’s dish (instead of or in addition to adding oil to the communal pot before serving individual family members).

Subsequent home visits and group meetings enabled researchers to learn about enabling and constraining factors faced by caregivers in adopting new recipes and improved IYCF practices and allowed communities to adapt and improve upon change strategies based on emerging lessons. Growth monitoring and promotion activities were also carried out at every community visit.

Infant and child feeding index

The ICFI used to evaluate changes in IYCF practices resulting from the intervention program was constructed as previously reported in **Chapter 3**.

Measurement of other variables

WHO IYCF indicators: Three of the new WHO IYCF indicators (see **Chapter 3**) were included in analyses: 1) indicator 5, minimum dietary diversity for children aged 6-23 months (children must consume four or more different foods groups in the previous 24 hours to achieve this minimum; seven food groups are considered, the same as those described above for the ICFI), 2) indicator 6, minimum meal frequency for children aged 6-8 months (children must consume solid, semi-solid or soft foods at least twice in the previous 24 hours to achieve this minimum)

and 9-23 months (children must consume solid, semi-solid or soft foods at least three times in the previous 24 hours to achieve this minimum), and 3) indicator 7, minimum acceptable diet for children aged 6-23 months. Indicator 7 is the only summary measure included in the new indicators, that is, it is the only indicator attempting to capture more than one dimension of child feeding in a single indicator. It is a composite of indicators 5 and 6.

Knowledge of appropriate IYCF practices: Caregiver knowledge of appropriate infant and young child feeding practices was measured at baseline and endline using an identical sequence of 10 questions (see **Appendix D**). The content of the questions emphasized the feeding messages promoted throughout the intervention period. Each question was designed to have a clearly correct answer or range of answers.

Self-reported changes in feeding practices: Mothers were asked in the endline survey to talk about any changes they adopted in the feeding practices of their young children in the previous year. Survey enumerators did not suggest changed practices to respondents, but merely prompted them with an open-ended question and recorded all of the changed practices mentioned. Similarly, mothers were asked to recall the key steps in the preparation of the improved recipes developed during community recipe trials.

Household food insecurity: Household food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access (Coates et al, 2007) developed by the Food and Nutrition Technical Assistance (FANTA) Project as a tool for

measuring three “domains” of food insecurity found to be stable across countries and major population subgroups (Kendall et al, 1995; Frongillo and Nanama, 2006; González et al, 2008). These domains include: anxiety and uncertainty about food access, insufficient food quality, and insufficient food intake. The generic nine-item survey was adapted to the local Bolivian context through key informant interviews with community leaders and focus group discussions with families (see **Appendix C**). A continuous, 27-point score and a four-level, categorical variable were derived from the nine-item survey for use in analyses.

Household socioeconomic status: An index of household socioeconomic status (SES) was generated using a principal components analysis (PCA) in the same manner as previously described in **Chapter 3**.

Nutritional content of recipes: The research team weighed all ingredients, raw and cooked, and recorded preparation procedures for all improved recipes created by communities during recipe trials. Data on the weight of individual ingredients and the total serving size volume given to children of different ages during taste test trials were also collected. Leftovers were also weighed to calculate the total amount consumed by individual children. Caregivers in some communities were also asked to prepare a traditional complementary food recipe in addition to creating an improved recipe(s). Food weighings were conducted for these traditional recipes as well. All weighings were made with a Salter stainless steel digital kitchen scale (Salter Housewares, Kent, UK).

Statistical analysis

Analysis of variance was conducted to determine baseline differences in several child-, maternal- and household-level characteristics between treatment and control communities.

Stratification and matching methods using propensity scores were used to reduce bias in estimates of treatment effects resulting from imbalances in baseline characteristics between treatment groups. A propensity score for an individual is the conditional probability of being treated given information on a set of observed covariates (Rosenbaum and Rubin, 1983).

Propensity scores allow for the creation of a “quasi-randomized” experiment, but are conditional only on the covariates which the researcher has measured (D’Agostino, 1998).

Therefore, it is still possible that unobserved confounding factors exist that differ between treatment and control groups.

Propensity scores for analyses using stratification were estimated using logistic regression (i.e. the PROC LOGISTIC function in SAS) from a set of variables with the potential to predict differences in both measured outcomes (e.g. infant and child feeding practices) and treatment assignment²⁴ (Todd, 2008). Stratification, or subclassification, involves grouping individuals into strata based on observed characteristics (i.e. potential confounding variables) and making direct comparisons of treated and control individuals within the same stratum (D’Agostino, 1998). After stratification using the logit model, distributions of the observed variables were

²⁴ The following baseline variables, based on *a priori* considerations of factors that could potentially predict both feeding outcomes and treatment status, were used to construct propensity scores and matched treatment/control pairs: community elevation, distance of household to nearest health facility and market, animal ownership, total land area accessible to the household for raising crops, amount of potato and cereal grains seeded and harvested in most recent sowing and harvest cycles, a household food insecurity score, number of children less than 5 years of age in the household, maternal age, maternal education, parity, maternal knowledge of appropriate feeding practices, child age, child sex, child health status, and the location where the child was delivered.

statistically the same between treatment and control groups across quintiles of the propensity scores.

Propensity score matching techniques were also conducted to confirm the results of models incorporating stratified covariate information. Using matching techniques, control individuals are matched to treated individuals based on select observed characteristics. Propensity scores are calculated using information from multiple covariates to produce a single scalar summary of the variables (D'Agostino, 1998). Three matching techniques were computed using the MatchIt software package (Ho et al, 2007a; Ho et al, 2007b) in R (R Foundation for Statistical Computing, Vienna, Austria). For “optimal” and “nearest neighbor” matching, treatment households were matched to one control household. For “full” matching, one treatment household was matched to multiple control households. Models incorporating propensity scores based on stratification and matching techniques produced nearly identical results. Therefore, data are presented here are only from models using the stratification technique.

All statistical analyses were conducted in SAS (version 9.1, SAS Institute, Cary, NC) using the PROC MIXED procedure accounting for the nested design effect of the study (i.e. households within communities and communities within treatment groups; households and communities were entered into models as random effects) and using the Kenward-Roger method to adjust for unbalanced data. Analysis of covariance (ANCOVA) models are presented here using as a response variable, the difference in ICFI score between baseline and endline, and as independent variables, the baseline ICFI score and other potentially confounding variables. This

approach adjusts treatment effects for “regression to the mean” (Barnett et al, 2005). Repeated measures models were also conducted for all analyses and were found to produce results nearly identical to those of ANCOVA models. Only ANCOVA analyses are presented here. Cumulative logit models were run using the PROC LOGISTIC procedure to test for differences in proportions of categorical variables (e.g. the WHO IYCF indicators) between treatment and control groups from baseline to endline.

Two-way interaction terms between the treatment effect and all potential confounders were tested in all models. All significant interaction terms were included in the final models along with the main effects of every potential confounding variable. Standard assumptions of homoscedasticity and normality of errors were tested for all models and found not to be violated. Associations were considered significant at $p < 0.05$ and reported as marginally significant at $p < 0.1$.

Ethics

The study protocol was approved by the Cornell University Institutional Review Board for Human Participants. All individuals surveyed gave informed oral consent to participate in the study. Families received a 0.45 L bottle of vitamin A-fortified vegetable oil for each child weighed and measured as compensation for their participation.

5.3 Results

Sample characteristics

At baseline, data were collected on 337 children aged 0-26 months from 331 households. At endline, data were collected on 436 children aged 0-36 months from 390 households. Data were available at both time points for 260 children from 256 households. However, only children aged 6-36 months were included in ICFI analyses. From the baseline sample, one observation was excluded because of unreliable birthdate data and 73 observations were excluded because the children were younger than six months of age. Data for children older than 24 months of age (maximum of 26 months) were collected from 18 families and included in the baseline sample. Therefore, valid ICFI scores were obtained for 263 children at baseline. Data were available for 201 of these children from the endline sample, however, 9 were older than 36 months and were dropped from ICFI analyses. In total, longitudinal data on 192 children were thus retained for final ICFI analyses.

Table 13 shows the mean baseline values for a range of child-, maternal-, and household-level characteristics between treatment and control groups. Though nearly all characteristics were balanced at baseline between the two groups, three differed: maternal age (mothers in control communities were on average older than mothers in treatment communities), knowledge of appropriate feeding practices (mothers in control communities scored higher on average on a ten-point knowledge scale than mothers in treatment communities), and potato seed planted (households in treatment communities seeded more potato on average in the previous sowing season than households in control communities). Seeding rates for potato in this region of

Bolivia are approximately 1100 kg/ha (Vanek, 2010). This difference of 92 kg in potato seeding between treatment and control communities then represents a mean difference in land area seeded to potato of approximately 0.08 ha.

Knowledge of appropriate feeding practices and self-reported changes in feeding practices

Figure 12 shows that the majority of women from treatment communities interviewed during the endline household survey in March 2010 were able to recall some information from intervention activities related to improved IYCF practices (59%) and improved recipes (66%). A smaller percentage of women recalled all five recipes steps for the enriched potato purée recipe (16%) and the three steps for the toasted flour mix recipe (44%). More than half of women interviewed reported adopting at least one new IYCF practice since the start of the Intervention (57%) and ever preparing an improved recipe (59%). A smaller percentage of women reported adopting multiple improved IYCF practices (33%), preparing the enriched

Table 13. Comparison of mean baseline characteristics between households in treatment and control communities.

	Treatment	Control
<i>Communities</i>	13	31
<i>Households</i>	78	114
<i>Child characteristics</i>		
Age (months)	14.1 ± 5.2	14.1 ± 5.7
Sex (% male)	56.4%	49.1%
Height-for-age Z-score	-2.1 ± 1.2	-2.1 ± 1.3
% stunted	50%	47.4%
Weight-for-age Z-score	-1.2 ± 1.0	-1.1 ± 1.0
% underweight	19.2%	16.7%
Health status (% with diarrhea in past two weeks)	68%	57%
<i>Maternal characteristics</i>		
Age (years)*	29.6 ± 8.1	32.1 ± 7.3
Height (cm)	149.1 ± 5.0	150 ± 5.4
Parity	3.3 ± 2.0	3.9 ± 2.0
Education (% not completing primary school)	91%	96.5%
Infant and child feeding index score	6.2 ± 1.4	6.4 ± 1.6
% of mothers giving any breastmilk	93.6%	86.0%
Number of different food groups (total of 7) fed in previous 24 hours	2.9 ± 1.3	2.6 ± 1.3
Number of different food groups (total of 7) fed in previous 7 days	3.3 ± 1.4	3.6 ± 1.8
Number of times solid or semi-solid foods fed in previous 24 hours	2.3 ± 0.9	2.4 ± 1.0
Feeding knowledge score*	4.2 ± 1.9	4.8 ± 1.6
% giving birth at home (most recent birth)	83.3%	87.7%
<i>Household characteristics</i>		
Number of children <5 years of age in household	1.5 ± 0.6	1.6 ± 0.6
Land area accessible for raising crops (ha)	0.74 ± 0.58	0.63 ± 0.55
Distance to nearest health facility (hours by foot)	1.9 ± 1.2	2.2 ± 1.2
Distance to nearest market (hours by foot)	2.2 ± 1.2	2.3 ± 1.2
Potato seeded previous year (kilograms)*	296 ± 256	204 ± 179
Cereal grain seeded previous year (kilograms) ¹	56 ± 54	54 ± 62
Number of sheep and goats owned	27 ± 20	25 ± 18
Household Food Insecurity Access Score (HFIAS)	4.9 ± 3.9	4.6 ± 4.5
<i>Community characteristics</i>		
Elevation (meters above sea level)	3538 ± 359	3529 ± 442

Values shown are means \pm SD or percent.

Asterisks denote characteristics whose mean baseline values are significantly different between treatment and control communities ($p < 0.05$).

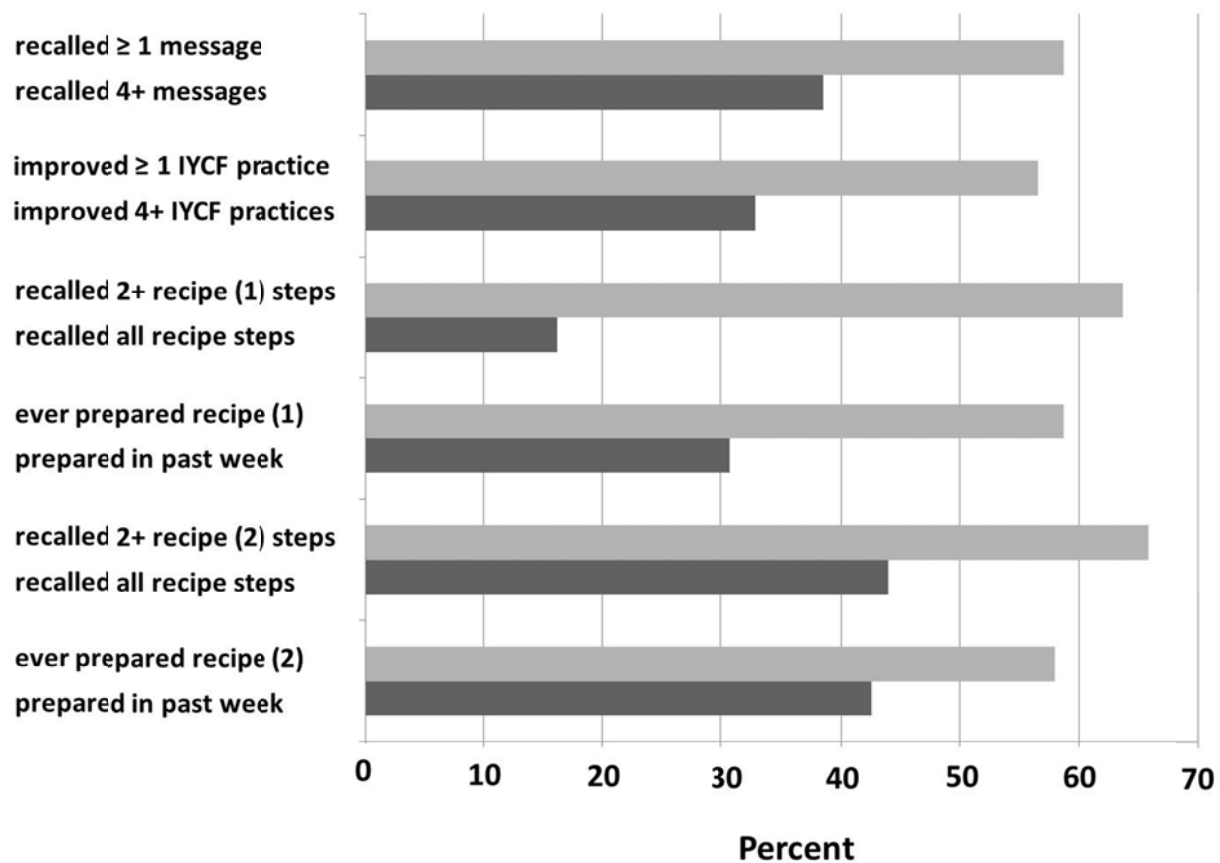
¹“Grain seeded previous year” is the total of all seed planted to wheat, maize and barley in the previous sowing season (i.e. October-November 2008).

potato purée recipe at least twice in the previous week (31%), or preparing the toasted flour mix recipe at least twice in the previous week (43%).²⁵ The number of intervention activities attended by women was strongly associated with both the number of key intervention messages recalled by women and the number of improved IYCF practices reported at endline (see **Figure 13**). Women who participated in more intervention activities recalled significantly more intervention messages and reported improving more IYCF practices on average than those women participating in fewer intervention activities.

Figure 14 shows that mothers’ self-report of changes in feeding practices in the previous year corresponds well with actual changes in IYCF practices as measured by the ICFI. Mothers who reported changing more IYCF practices since the start of the nutrition intervention exhibited more improved ICFI scores from baseline to endline. Mothers recalling a greater number of the key steps involved in the preparation of the improved recipes developed during community

²⁵ A mother did not need to apply every recipe step to her preparation to qualify as having prepared the recipes. Recipes steps were designed to achieve the maximum nutritional benefit to the child (e.g. including four different food groups in the family meal, purposefully placing a diverse selection of these foods on the child’s plate, draining excess water from the child’s dish to

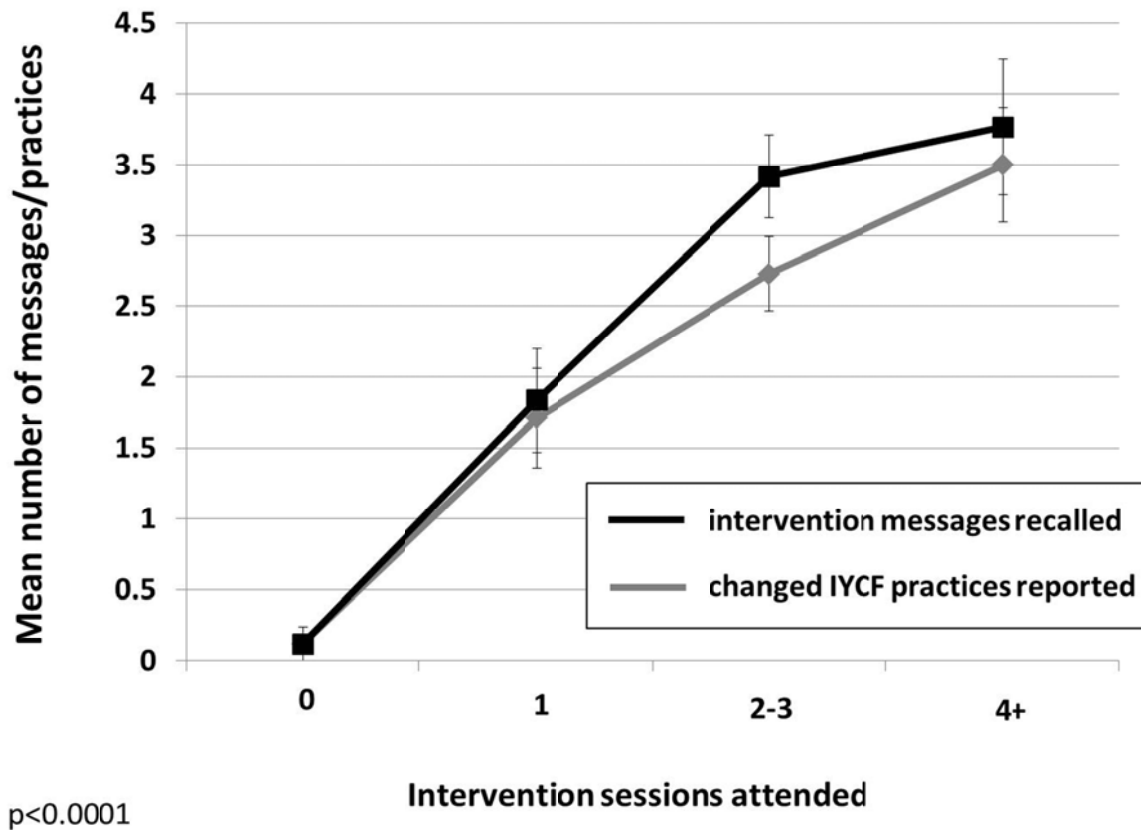
Figure 12. Percent of mothers recalling intervention messages and preparation steps for Trials of Improved Practices (TIPs) recipes and reporting adoption of improved feeding practices and improved recipes at endline.



“Recipe (1)” refers to the enriched potato purée recipe and “recipe (2)” refers to the toasted flour mix recipe (n=143).

increase consistency, and mashing the food for older infants and younger children), but all were not necessary to constitute an improvement over existing recipes.

Figure 13. Mean number of intervention messages recalled at endline and mean number of changed feeding practices reported at endline by mothers by the number of intervention sessions attended.

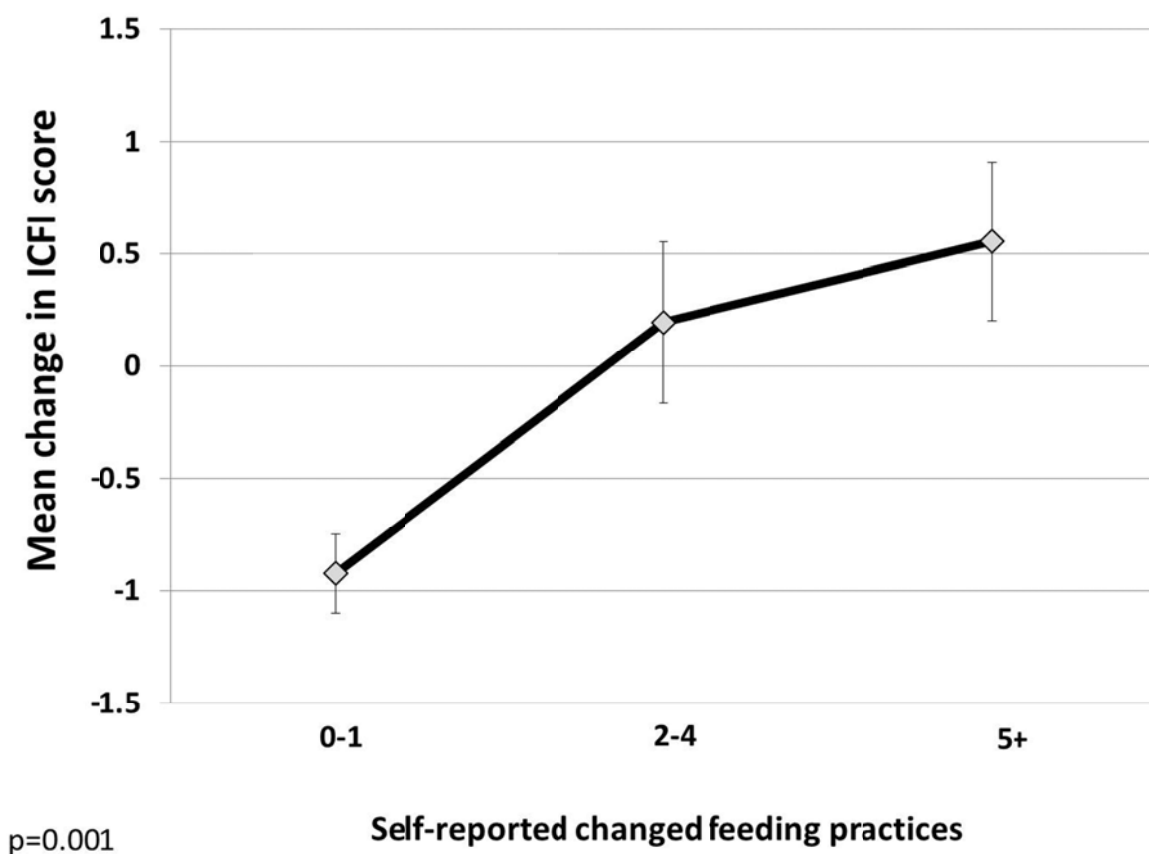


Means \pm SEM are shown. P-value is for differences in messages recalled and changed IYCF practices reported between mothers attending zero compared to 4 or more intervention sessions. Significant differences ($p<0.05$) were also observed for both messages recalled and changed IYCF practices reported by mothers who attended 0 vs. 1 session, 0 vs. 2-3 sessions, 1 vs. 4 or more sessions, and for messages recalled only, 1 vs. 2-3 sessions ($n=143$).

recipe trials also showed more improved ICFI scores as compared to mothers recalling fewer or none of those steps ($p<0.05$; data not shown).

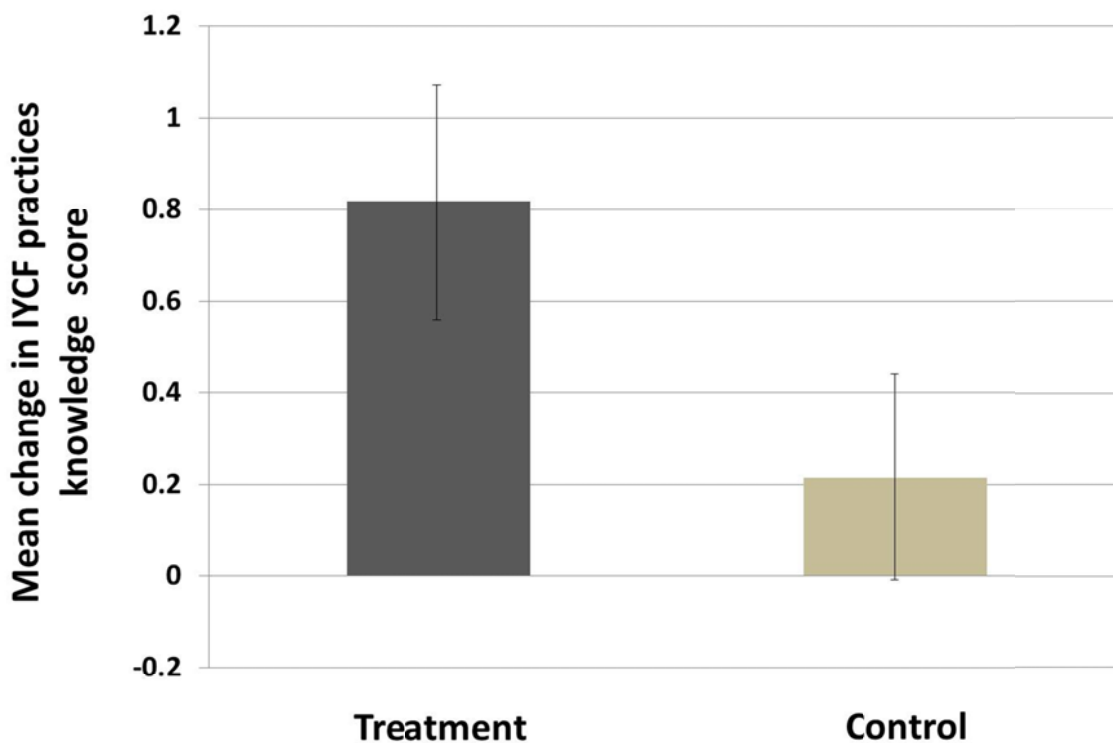
Knowledge of appropriate IYCF practices improved significantly more from baseline to endline among caregivers from treatment communities compared to those in control communities ($p < 0.05$) (see **Figure 15**). The mean change in caregivers' knowledge score was adjusted by the baseline knowledge score and several other covariates.

Figure 14. Mean change in feeding index score between baseline and endline by self-reported changes in feeding practices.



Means \pm SEM are shown. The p-value is for the difference between the highest and lowest categories of self-reported changed feeding practices ($n=192$).

Figure 15. Mean adjusted change in feeding practice knowledge score by treatment assignment.



$p < 0.05$

Means \pm SEM are shown and are adjusted by baseline IYCF practices knowledge score, propensity score quintiles, child age, child sex, mother's age, mother's education, household size and socioeconomic status. The knowledge score is based on a series of ten questions administered to caregivers at baseline and endline that test knowledge of appropriate IYCF practices (n=256).

Changes in feeding practices

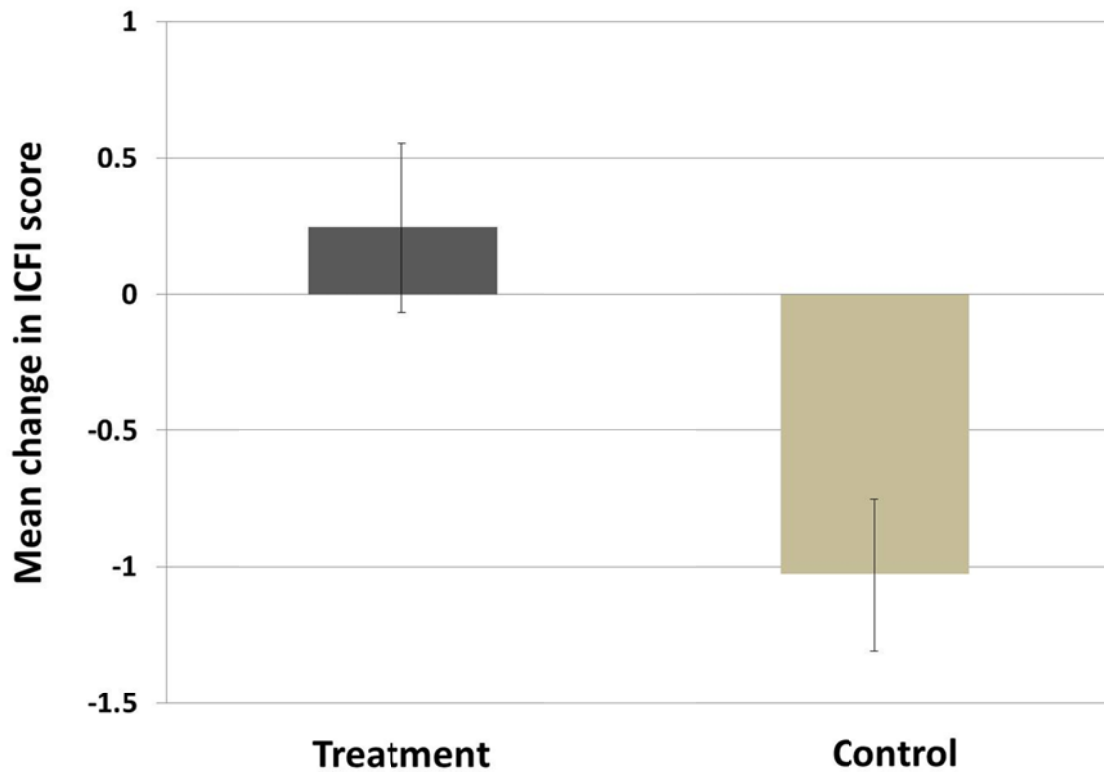
After adjusting for differences in baseline characteristics between treatment groups using propensity score stratification by quintiles and controlling for several potentially confounding variables, mothers in intervention communities demonstrated improvement in ICFI scores from baseline to endline while mothers in control communities showed a marked decline in those scores (see **Figure 16**). The mean adjusted difference in ICFI score for mothers in intervention

communities was 0.24 points while the mean difference for mothers in control communities was -1.02 points. Treatment assignment interacted with household socioeconomic status (see **Figure 17**) such that feeding practices of mothers in households of lower SES in control communities deteriorated to a greater extent than those of mothers in households of higher SES. In contrast, there were no differences in the improvement of IYCF practices in treatment communities between households of varying socioeconomic status. **Table 14** shows the regression coefficients and associated p-values for the ANCOVA multiple regression analysis.

Table 15 shows the differences in individual ICFI components between treatment and control groups. There were no differences between treatment and control groups at either baseline or endline in the proportion of mothers still breastfeeding or bottlefeeding their children. The percentage of mothers breastfeeding their children decreased by 41% and 39.5% in treatment and control groups, respectively, between baseline and endline. Likewise, as children grew older, the percentage of mothers bottlefeeding decreased by 15.4% and 10.6% in treatment and control groups, respectively. The change in the proportion of mothers breastfeeding and bottlefeeding their children from baseline to endline did not differ between treatment and control groups. The adjusted mean difference in indicators of diet diversity in the previous 24 hours and 7 days between baseline and endline was consistently more positive for those in the treatment group as compared to the control group. This difference was significant ($p < 0.05$) for diet diversity in the previous 7 days. The difference in the frequency of feeding solid or semi-solid foods in the previous 24 hours was significantly greater for mothers in the treatment group as compared to the control groups ($p = 0.01$). **Figure 18** shows graphically the differences

in diet diversity and feeding frequency elaborated in **Table 15**.

Figure 16. Mean adjusted change in feeding index score by treatment assignment.

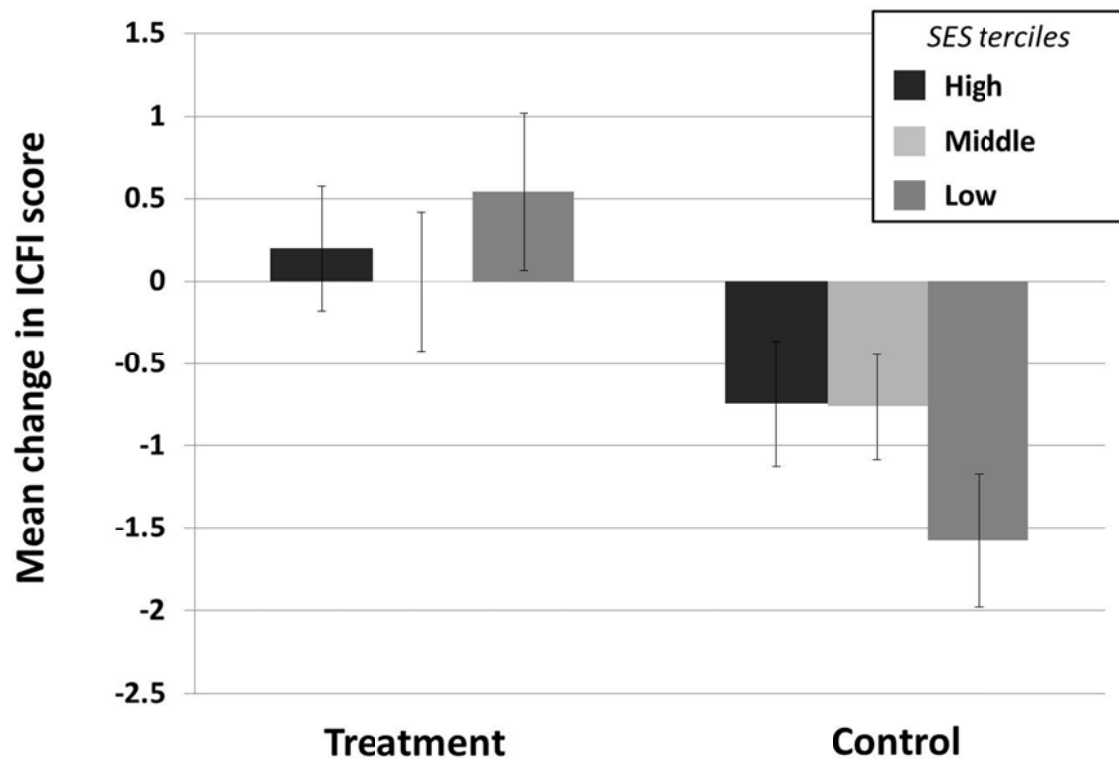


p=0.0003

interaction with household SES: p<0.05

Mean change in ICFI score (shown as mean \pm SEM) is adjusted by baseline ICFI score, baseline IYCF practices knowledge score, propensity score quintiles, child age, child sex, child health status, mother's age, mother's education, household size and socioeconomic status (n=192).

Figure 17. Mean adjusted change in feeding index score by treatment assignment for each level of socioeconomic status.



interaction: $p < 0.05$

Mean change in ICFI score (shown as mean \pm SEM) is adjusted by baseline ICFI score, baseline IYCF practices knowledge score, propensity score quintiles, child age, child sex, child health status, mother's age, mother's education, household size and socioeconomic status. This SES factor primarily explains variation in land and animal ownership as well as the amount of seed planted to cereal grain and potato between households ($n=192$).

Table 14. Regression coefficients and associated p-values of the determinants of mean change in feeding index score based on results of analysis of covariance.

<i>Response variable: change in ICFI score</i>		
Independent variable	Regression coefficient	p
Treatment group (control)	interaction	interaction
Baseline ICFI score	-0.783	<0.0001
Baseline IYCF practices knowledge score	0.025	0.815
Propensity score quintiles	0.087	0.626
<i>Child characteristics</i>		
Child age in months	-0.015	0.511
Child sex (male)	0.334	0.147
Child health (no diarrhea)	0.139	0.561
<i>Maternal characteristics</i>		
Maternal age in years	0.008	0.751
High: Mother's education level (low) ¹	1.717	0.005
Mid: Mother's education level (low)	0.670	0.054
<i>Household characteristics</i>		
High tercile: SES factor 1 (low)	-0.045	0.904
Mid tercile: SES factor 1 (low)	-0.074	0.848
High tercile: SES factor 2 (low)	interaction	interaction
Mid tercile: SES factor 2 (low)	interaction	interaction
Treatment group*High tercile: SES factor 2 ²	-1.1718	0.078
Treatment group*Mid tercile: SES factor 2	-1.3596	0.038

P-values <0.1 are highlighted in bold face.

Labels in parentheses next to categorical variable names signify the reference level used for that independent variable.

Where interaction terms were found to be significant, regression coefficients and p-values of main effects are omitted.

¹Mother's education level is divided into three categories: mothers in the "low" education category received no formal education of any kind, those in the "mid" category entered primary school but did not complete it, and those mothers in the "high" category completed primary school or received even further education.

²This combined term in the model represents the interaction of treatment group assignment and household socioeconomic status. The reference categories are the "control" treatment assignment and the "low" tercile of SES factor 2.

Table 15. Differences from baseline to endline in feeding index score components and World Health Organization indicators between treatment and control groups.

<i>ICFI components</i>			
ICFI component	Treatment	Control	p value
Still breastfeeding at baseline (%) ¹	93.6	86.0	0.10
Still breastfeeding at endline (%)	52.6	46.5	0.41
Difference (%) ²			0.88
Bottlefeeding at baseline (%)	29.5	21.1	0.18
Bottlefeeding at endline (%)	14.1	10.5	0.45
Difference (%)			0.57
Mean difference in the number of different food groups consumed in previous 24 hours ³⁻⁶	0.48	0.30	0.62
Mean difference in ICFI 24-hour diet diversity score	0.10	-0.11	0.21
Mean difference in the number of different food groups consumed in previous 7 days ³⁻⁶	0.91	0.34	0.046
Mean difference in ICFI 7-day food frequency score	0.09	-0.15	0.089
Mean difference in the number of times solid, semi-solid, or softs foods were fed in previous 24 hours ³⁻⁵	1.53	0.47	0.009
Mean difference in ICFI feeding frequency score ⁷	0.33	-0.16	0.008
<i>WHO indicators</i>			
WHO indicator	Treatment	Control	p value
Minimum dietary diversity (6-23 mo)			
Achieved minimum at baseline (%)	35.3	18.8	0.09
Achieved minimum at endline (%)	50.0	45.8	0.71
Difference (%)			0.20
Minimum meal frequency (6-23 mo)			
Achieved minimum at baseline (%)	35.3	66.7	0.005
Achieved minimum at endline (%)	67.7	54.2	0.22
Difference (%)			0.17
Minimum acceptable diet (6-23 mo)			
Achieved minimum at baseline (%)	14.7	18.8	0.63
Achieved minimum at endline (%)	44.1	31.3	0.23
Difference (%)			0.44

P-values <0.1 are highlighted in bold face.

The sample size for analyses of ICFI components is n=192. The sample size for analyses of WHO indicators is n=82.

¹The p values shown for all individual baseline and endline percentages in this table are for the Pearson Chi-square statistic testing unadjusted differences in proportions between treatment and control groups.

²The p values for all differences in percentages in this table are for the treatment effect in cumulative logit models testing for differences in the change in proportions of the given variable from baseline to endline. The response variables for all logit models were three-level variables (e.g. change in proportion achieving WHO-defined minimum diet diversity: 'positive change' [did not achieve the minimum at baseline, but achieved the minimum at endline]; 'no change' [either achieved or did not achieve the minimum at both baseline and endline]; 'negative change' [achieved the minimum at baseline, but did not achieve the minimum at endline]. Treatment effects were adjusted by baseline feeding score, child age, child sex, health status, maternal education, maternal age, mother's knowledge of appropriate feeding practices, and household size and socioeconomic status.

³Means are adjusted by the same covariates as those in cumulative logit models.

⁴The variables denoted as "scores" are the actual ICFI score values for those components. The variables directly above those score components are the characteristics from which the scores are based. For example, the number of different food groups consumed in the previous 24 hours was first calculated, and from this value the ICFI 24-hour diet diversity score was calculated.

⁵P values are for the adjusted effect of the treatment on the difference in the respective ICFI component between baseline and endline.

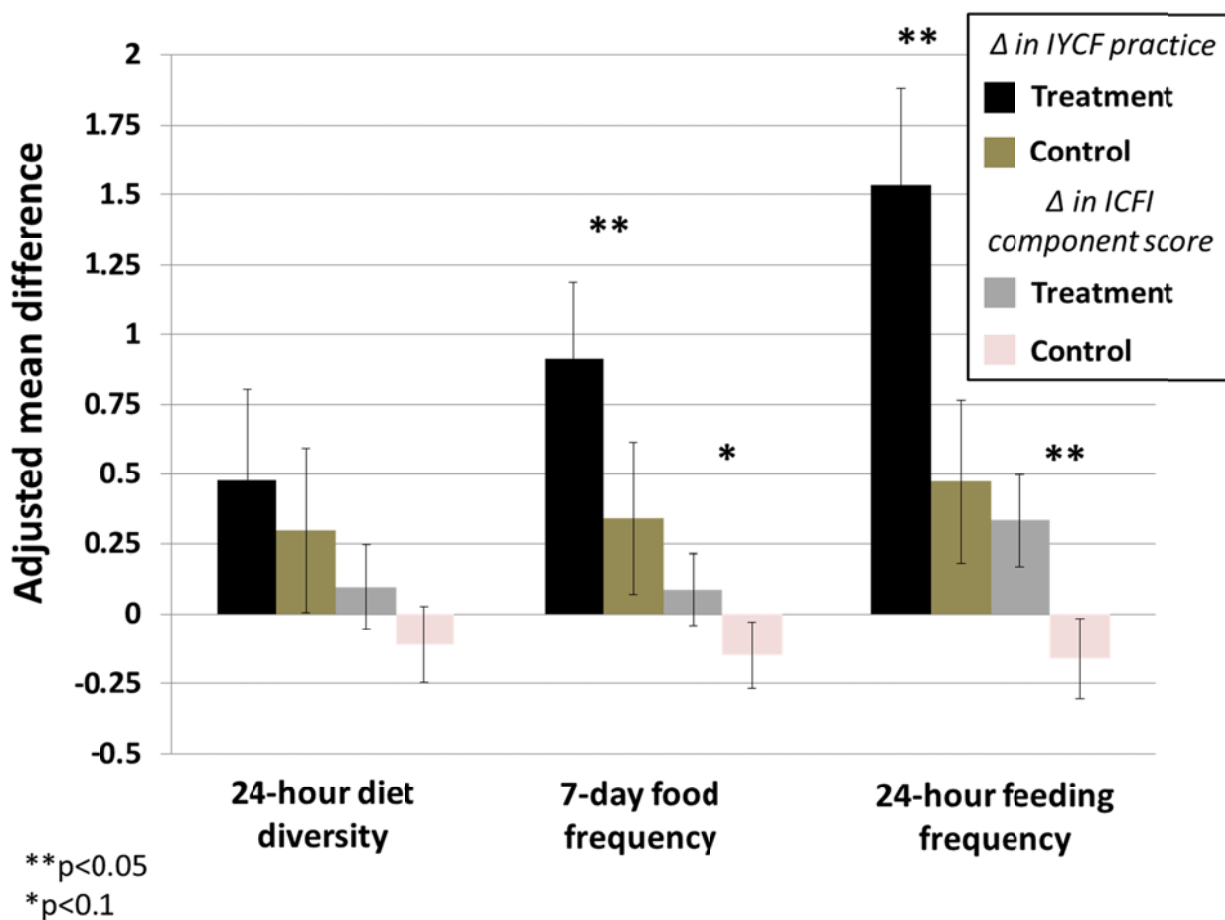
⁶The number of food groups consumed is calculated from a maximum of seven food groups: 1) cereal grains, roots, and tubers, 2) legumes and nuts, 3) dairy products (milk, yogurt, cheese), 4) flesh foods (meat, fish, poultry and liver/organ meats), 5) eggs, 6) vitamin-A rich fruits and vegetables, and 7) other fruits and vegetables.

⁷Meal frequency scores range from 0-2 for children 6-8 and 9-11 months and 0-3 for children 12-36 months. For these analyses, scores of 2 and 3 were combined for children aged 12-36 months.

For the smaller sample of children for which data were available at both baseline and endline to construct the WHO IYCF indicators, **Table 15** shows that the proportion of children achieving minimum diet diversity ($p < 0.1$) and meal frequency ($p < 0.01$) differed at baseline between treatment and control groups. **Table 15** also shows that at baseline, a marginally larger proportion of children in treatment communities achieved minimum diet diversity ($p < 0.1$) compared to children in control communities and a larger proportion of children in control

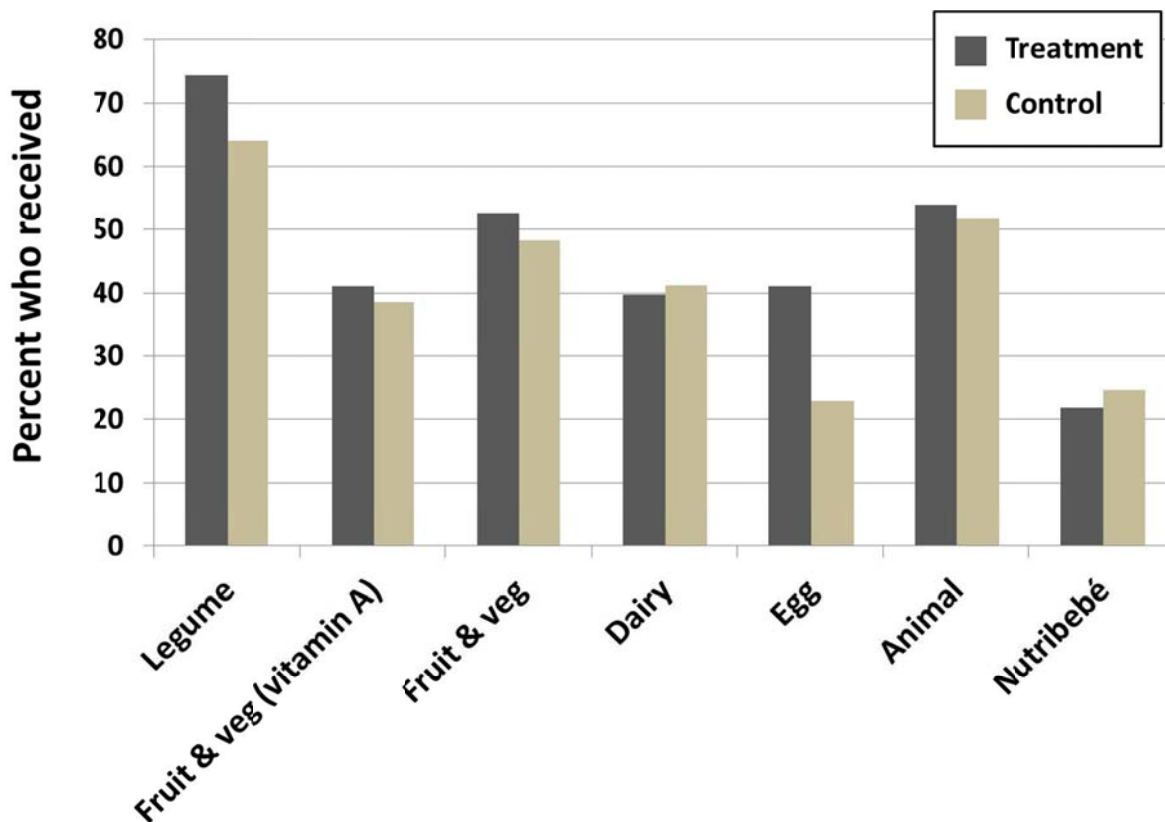
communities achieved minimum meal frequency ($p<0.01$) compared to children in treatment communities.

Figure 18. Mean adjusted differences in feeding practices and feeding index component scores by treatment assignment.



Means \pm SEM are shown. The IYCF practices associated with “24-hour diet diversity”, “7-day food frequency” and “24-hour feeding frequency”, respectively, are as follows: the mean difference in the number of different food groups consumed in previous 24 hours, the mean difference in the number of different food groups consumed in previous 7 days, and the mean difference in the number of times solid, semi-solid, or softs foods were fed in previous 24 hours. Mean differences are adjusted by baseline ICFI score, baseline IYCF practices knowledge score, child age, child sex, child health status, mother’s age, mother’s education, household size and socioeconomic status ($n=192$).

Figure 19. Percentage of children at endline consuming foods from select food groups at least once in the previous seven days.



Percentages are shown for each treatment assignment. The “legume” group includes peas, fava beans, Andean lupin and common bean. The “fruit & veg (vitamin A)” group includes vitamin-A rich fruits and vegetables such as carrots, squash and Swiss chard (the “fruit & veg” group includes all other non-vitamin A-rich fruits and vegetables). Nutribébé is a fortified milk powder distributed free of charge to eligible families with infants and young children aged 6-24 months. Nearly all children in both treatment and control communities received a cereal grain or tuber in the previous seven days (these data are not shown) (n=192).

There were no differences between treatment groups in the proportion of children whose diets improved (i.e. “did not achieve the minimum” at baseline and “achieved the minimum” at endline), deteriorated (i.e. “achieved the minimum” at baseline and “did not achieve the minimum” at endline), or remained the same from baseline to endline according to the scoring

of the three WHO IYCF indicators used in the analyses: minimum diet diversity, minimum meal frequency, and minimum acceptable diet.

Changes in child growth

No significant differences were found between treatment groups in either the change in average height-for-age Z-score, weight-for-age Z-score or the change in the prevalence of stunting or underweight from baseline to endline. Among the 192 children included in the analysis, mean height-for-age Z-score declined in both intervention and control groups from baseline to endline by 0.34 HAZ while mean weight-for-age Z-score increased by 0.13 WAZ in intervention communities and 0.09 WAZ in control communities.

5.4 Discussion

Intervention impact

The mean ICFI score of caregivers in communities where the nutrition education intervention was implemented improved during the one-year research period whereas the mean score of caregivers in control communities declined. This decline in the mean ICFI score of caregivers from control communities is a reflection of a failure to improve feeding practices to meet increasing dietary requirements as children grow older.

As children move from infancy into the second and third years of life, they require more frequent meals, larger quantities of food, an increased consistency of foods and a continuing diversity of foods (Dewey, 2003). This change in requirements is reflected in the age-specific

scoring system of the ICFI. For example, to achieve the highest score for the 24-hour diet diversity component of the ICFI, children aged 12-36 months must have received at least 4 or more food groups in the previous 24 hours compared to only 3 for infants aged 6-8 months. Likewise for the feeding frequency component, children aged 12-36 months must have been fed solid or semi-solid foods at least 3 times in the previous 24 hours to receive a high score on that ICFI component compared to only two meals for children aged 6-8 months. If mothers adapt to the increased feeding requirements as their children age, then ICFI scores will remain constant over time or may even improve. However, if the diversity of the diet and the frequency of feeding remain relatively constant, ICFI scores will decline as children age reflecting an insufficient increase in diet quantity and quality to meet changing requirements. And indeed, a “regression to the mean” effect was observed in the data (see “baseline ICFI score” regression coefficient in **Table 14**) such that the mean ICFI scores of caregivers with higher baseline scores declined over time. This regression reflects in part the challenge caregivers face in maintaining positive feeding practices as children age.

In northern Potosí, as children grow older, their diets often fail to meet changing requirements for several reasons. In this region of Bolivia, diets are largely potato-based from infancy to adulthood. While cereal grains, legumes and occasional fruits, vegetables and animal-source products are also included in family meals, the diversity of diets does not vary greatly from month to month or year to year. There are currently no international, age-specific recommendations for adequate dietary diversity, nor would such recommendations likely be meaningful given the importance of local foods and consumption patterns in defining diet

quality (Ruel, 2003). However, data suggest that child diets in northern Potosí are not adequate. Seventy-one different foods were reported in 718 dietary recall questionnaires from both survey rounds, however, roots and tubers contributed on average 54% of children's dietary energy at baseline and 58% at endline. At baseline, children in both treatment and control communities on average received foods from fewer than four different food groups during the previous week (see **Table 13**). For all food groups except for cereal grains, tubers and legumes, the majority or near-majority of children did not receive a food item from those groups in the previous seven days (see **Figure 19**). And these data were collected during a period of the year (i.e. March) when the availability of many foods, in particular animal-source foods, is at its peak. Previous research in the region has identified multiple micronutrient deficiencies in child diets, namely riboflavin, calcium and vitamin A, and severely restricted fat intakes (Berti et al, 2010).

Despite its importance as a predictor of child nutritional status (Onyango et al, 1998; Hatløy et al, 2000; Arimond and Ruel, 2002; Ruel and Menon, 2002; Arimond and Ruel, 2004), dietary diversity is not always a priority for families. Widespread poverty and a harsh physical environment for raising crops present obstacles to obtaining sufficient food throughout the year. In this resource-limited environment, caregivers tend to emphasize providing a sufficient quantity of food to family members rather than a large diversity of selections. And food availability is largely predicted by seasonality and agronomic conditions. During the wet season from January to March and leading up to the May potato harvest, a larger variety of foods, including milk, meat, cereal grains and fresh legumes are available. As the rains subside and

food stores steadily decline into the dry winter months of July through November, some families end up subsisting almost entirely on potatoes and *chuño* (freeze-dried potato). If crops fail due to frost, hail, lack of rain, heavy rains, pests or disease, household diets may be even more severely restricted. Therefore, even in households where diet diversity is a priority, improving it substantively and consistently throughout the year is a considerable challenge.

Particularly beyond infancy, children's diets are also rarely seen as requiring special attention as compared to adult diets. Infants and young children are commonly fed watery, potato-based broths into their second year of life when they begin to gain the ability to grasp foods and feed themselves. As they graduate from these broths, they are increasingly served food from the common family pot like any other family member, albeit in smaller portions. Therefore, their food is not prioritized to receive special attention or include a larger diversity of ingredients from the common pot. The finger foods and snacks infants and young children receive throughout the day are often also inadequate. Women in this region of Bolivia have numerous work responsibilities including tending to mixed herds of sheep, goats and llamas—a task which may require walking several hours to reach pastureland and then further walking upon reaching that pastureland to ensure animals graze only within a confined area. Women then, because they are ever moving and relocating, carry their young ones on their backs while they work throughout the day, feeding them passively by handing them easily transportable foods such as whole potatoes or *chuño*. The child, however, left to a private, unsupervised and unassisted meal while the mother tends to her animals, can have difficulty handling, consuming and chewing these unwieldy foods without the proper assistance.

The nutrition education intervention directly confronted several of these barriers to improving IYCF practices. Among the five feeding messages promoted and the creation of improved complementary food recipes using locally-available foods, the role of women as agriculturalists and the interaction of this role with IYCF practices were emphasized. Intervention meetings sought to enhance caregiver capacity to improve IYCF practices by strengthening intracommunity collaborations. These collaborations included 1) sharing responsibilities for tending animals and sowing and harvesting crops, 2) preparing nutritious “field” meals that could be easily transported and shared between caregivers and children on joint herding days, and 3) creating community food baskets to increase whole community access to diverse foods. (Individual families had access to different kinds of crops based on the types of crops they chose to grow, their access to land and irrigation water, and their access to relatives’ crops in different agroecological zones; attempts were made to pool and share this diversity within the community). And indeed, caregivers in treatment communities showed significantly improved ICFI component and composite scores compared to control communities.

Table 15 and **Figure 18** show that the mean increase in both the number of times solid or semi-solid foods were fed in the previous 24 hours and the number of different foods consumed in the previous week was significantly lower for children of caregivers in control communities as compared to treatment communities²⁶. These two components strongly contributed to the

²⁶ Another child feeding practice that showed improvement in treatment communities was the consistency of foods fed to infants and young children. The consistency of semi-solid foods or purées fed to children in the previous 24 hours was significantly thicker for children in treatment communities as compared to those children in control communities even controlling for the age of children. Consistency was measured by showing respondents a standardized series of 4 photographs showing purées with increasingly thicker consistencies and asking respondents to select which photo represented the consistency of the meal fed to their child during the 24-hour recall.

difference in the change in composite ICFI score from baseline to endline observed between treatment and control groups. The mean increase in the treatment group in the number of times solid or semi-solid foods are fed daily (1.5) is slightly lower than recommendations for increased number of daily feeds as children move from infancy into their second year of life (Dewey, 2003).²⁷ And children in treatment communities on average added nearly one additional food group (0.91) to their weekly diet. This observed change in dietary diversity in the treatment group, though an important initial step toward improving child diets, does not appear to have been sufficient in magnitude or quality to be nutritionally significant, however. Mean height-for-age Z-score declined during the one-year observation period in both intervention and control communities and no differences were observed between treatment groups in any anthropometric indices. Data from **Chapter 3** demonstrated that after adjusting for a number of covariates, an ICFI was associated with child growth in this population; a one-unit increase in the ICFI score of mothers with children aged 12-36 months corresponded to an increase of 0.13 HAZ. The mean ICFI score did not improve to this extent, however, in treatment communities. The adjusted mean increase in ICFI score for mothers in the treatment group was 0.24, which if fitted to the above-calculated regression line, would only result in an increase of 0.03 HAZ.

If the observed treatment effects in this study are indeed due to the nutrition intervention, it seems plausible that the intervention, without introducing external resources to communities,

²⁷ Though recommendations depend on the energy density of complementary foods and the usual amount consumed, it is recommended that children aged 6-8 months are fed 2-3 times per day while children older than one year of age are fed 4-6 times (including snacks).

succeeded in preventing a deterioration of adequate feeding practices as children grew older and indeed modestly improving these practices, but did not sufficiently improve child diets so as to have a substantive impact on growth.

Other education-only, programmatic interventions (i.e. non-efficacy trials) have shown mixed impacts on child growth (Dewey and Adu-Afarwuah, 2008). A behavior change communication program in Madagascar (Essential Nutrition Action) worked with mothers of children aged 6-23 months to promote optimal breastfeeding, complementary feeding and actions to control several micronutrient deficiencies (Guyon et al, 2006). Children were consuming significantly more fruits, vegetables, fish and oils at endline compared to baseline, but demonstrated no improvement in growth after 5 years. In India, following 7-12 months of an education-only nutrition intervention, mothers of infants aged 5-11 months were feeding their children a larger diversity of foods and more frequently (Kilaru et al, 2005). With respect to growth outcomes however, only the weight velocity of female infants showed improvement. In rural Nicaragua, households participating in a two-year health and nutrition intervention demonstrated an overall increase in food expenditures and an increased purchasing of nutrient-dense foods (i.e. fruits, vegetables and meat) (Maluccio and Flores, 2004). In double-difference estimate calculations, children aged 0-59 months of families exposed to the intervention showed a decreased prevalence of stunting and underweight and improved HAZ compared to control children. The intervention program in this context differed from the program in northern Potosí though in that participating families received a cash transfer, and health counseling and supplies (e.g. antiparasitics, vitamins and iron supplements) for attending health education

workshops. In rural Sichuan China, children aged 12 months whose mothers participated in a nutrition education intervention for an entire year showed an increased daily intake of a variety of foods including fruits and animal-source foods and improved height-for-age and weight-for-age compared to control mothers (Guldan et al, 2000). Again though, the study population in this region of China differed significantly from that of northern Potosí in that families had widespread year-round access to eggs, vegetables, rice, oil and meat.

The relatively short duration of the intervention in this study, its targeting not only of infants, but children from birth to three years of age, its emphasis on using only local resources to improve IYCF practices in such a food insecure and impoverished environment, and the existence of other limiting factors such as poor access to health services and unsanitary home environments may be contributing factors to the modest improvement in child feeding practices and lack of improvement in child growth observed. The extreme isolation of the communities in this region of Bolivia, both geographically and economically, presents a considerable challenge to the delivery of goods and services. Therefore, food fortification, vitamin supplementation and the supply of outside complementary foods may have only a limited impact on improving child malnutrition. Food-based solutions, if developed coherently and incrementally across sectors and institutions, present a more appropriate approach to confronting the seemingly intractable problem of undernutrition in northern Potosí.²⁸ Such solutions might emphasize diversifying farming systems to include the production of nutrient-rich foods, improving overall farm productivity, strengthening market linkages and increasing

consumer demand of local foods to improve farmer incomes, and revaluing the role of women as both caregivers and agriculturalists to enhance their control of income from agricultural activities and preserve their time available for child care. Providing nutrition education parallel to these efforts is also important, and may be particularly so for low-income households.

In control communities, ICFI scores of mothers from households with less access to productive resources declined to a significantly greater extent than those of households with more access to resources. However, in treatment communities there were no differences between levels of socioeconomic status in improvement in ICFI scores (see **Figure 17**). This suggests that intervention benefits were equally attainable across socioeconomic strata. Data from **Chapter 3** showed that children from households with less access to productive resources may benefit disproportionately from improved feeding practices. With evidence that an education-only intervention can prevent the deterioration in the quality of child diets and IYCF practices as children age, regardless of household access to resources, consistent nutrition education may be critically important to seeing improvements in child nutrition, particularly for poorer households.

Plausibility of intervention effect

Habicht and others discuss three different kinds of assessments available to program evaluators depending on the design of the evaluation and available evidence (Habicht et al, 1999). These include: adequacy, plausibility and probability assessments. The level of inference evaluators

²⁸ The percentage of under-five children suffering from moderate to severe stunting in northern Potosí (54.6% at endline) is

can draw from results varies depending on the assessment type. In adequacy assessments, evaluators seek to measure if expected changes occurred in a population. No comparison groups are included in these designs; results are compared only to predefined adequacy criteria. Probability assessments require randomization of treatment and control units to comparison groups. This allows for the measurement of the probability of confounding. Plausibility assessments, the assessment type chosen for this study, attempt to control for the influence of confounding factors on treatment effects by including one or more control groups in the research design.

Plausibility assessments may be strengthened by demonstrating: 1) the congruency of the expected trend (e.g. ICFI scores improved in treatment communities), 2) the observed trend is not due to general changes in the study area (e.g. ICFI scores did not improve in control communities), 3) lack of measurable confounding (e.g. changes in other known determinants of IYCF practices, SES for example, do not explain the observed trend), 4) congruency of dose-response (e.g. there exists a direct association between the intensity of the intervention in treatment communities and the treatment effect), 5) congruency of mediating variables (e.g. caregivers' knowledge of IYCF practices improved in treatment communities), and 6) congruency of lack of impact in the absence of the intervention (e.g. caregivers in treatment communities who did not participate in the intervention showed a decline in IYCF practices similar to that seen in control communities) (Habicht et al, 1999).

more than double that found at the national level in Bolivia (UNICEF, 2003).

Several of these criteria for strengthening the plausibility that an observed treatment effect was due to a given intervention are met in the current study. We demonstrate that ICFI scores did indeed improve in treatment communities (criterion 1) and did not improve in control communities (criterion 2). Numerous potential confounding variables were measured (e.g. knowledge of appropriate IYCF practices, child age, child sex, child health status, mother's age, mother's education, and household size and socioeconomic status) and controlled for in multivariate analyses. The observed trends in both treatment and control communities remained after adjustment for these variables, suggesting that these confounding variables do not explain the trends (criterion 3). Though caregivers who attended a larger number of intervention activities exhibited more improved mean ICFI scores compared to caregivers with lower attendance, this difference was not statistically significant (data not shown) (criterion 4). Caregivers who participated in only one intervention activity demonstrated a similar decline in mean ICFI score as caregivers from control communities. Participation in two or more intervention sessions, however, appears to have had a similar impact on improving ICFI scores regardless of the number of attendances. This finding suggests that even a low-intensity nutrition intervention may provide large returns in terms of improvements in IYCF practices in this region of Bolivia. However, without additional improvements to those factors that impact the basic and underlying causes of poor child diets and nutritional status (e.g. a diverse and productive agriculture, adequate income, particularly that controlled by women, gender equality, and access to health and social services), further education alone may not achieve additional gains.

Caregiver knowledge of appropriate IYCF practices, a mediating variable between the intervention and improved IYCF practices, improved to a greater extent in treatment communities as compared to control communities (see **Figure 15**) (criterion 5). ICFI scores for caregivers in treatment communities who did not participate in the intervention on average declined from baseline to endline (an adjusted mean difference of -0.19 points; data not shown). This decline was not as extensive as that seen in control communities (an adjusted mean difference of -1.03 points – see **Figure 16**), but does contrast with the increase in adjusted mean ICFI scores of caregivers from treatment communities who did participate in the intervention (an adjusted mean difference of 0.36 points; data not shown) (criterion 6).

Therefore, four of the six criteria for strengthening the plausibility of the observed treatment effect were met, and the remaining two demonstrated the expected trend. The additional application of stratification and matching techniques using propensity scores to adjust for baseline differences between treatment and control communities further strengthens the plausibility of the statement that observed differences in IYCF practices between treatment and control communities are due to the nutrition intervention.

Though the evidence supporting the plausibility of the observed treatment effect is strong, several aspects of the study design and research environment limit the extent to which causal inferences may be drawn in the context of this study. Given the non-randomized design of the study, it is possible that unmeasured characteristics in the study population explain the observed treatment effect. Without randomization, the probability of confounding cannot be

measured. The ubiquitous presence of NGOs in northern Potosí presents another complication. In this region of Bolivia, dozens of bilateral, multilateral and charitable organizations and institutions operate year-round supporting the provision of basic government services and providing direct assistance to communities. The research team spent a great deal of time traveling in the region, interacting with personnel from other organizations, and speaking with community members about their participation in different programs and activities. Aside from subsidized school feeding programs that regularly provide food stuffs to local schools in both treatment and control communities (which would not directly affect the preschool children involved in this research), and occasional growth monitoring visits to select communities by a staff member from the “comprehensive nutrition unit” (*Unidad de Nutrición Integral*) in the Sacaca hospital, the authors are not aware of any other nutrition-related activities that were being conducted in study communities during the course of this research. It is certainly possible, however, that such activities took place, thereby contaminating the “control” status of control communities or exaggerating effects seen in treatment communities.

Selection bias presents another potential source of error in this study. Limited staff resources were available for survey and programmatic work which necessitated targeting communities with at least five families with infants or young children. This targeting, therefore, excluded extremely small “hamlet” communities from the sample. Families in participating communities also self-selected to participate in household surveys and intervention activities. Survey coverage was high with more than 90% of eligible families participating in either survey round. Non-participating eligible families for which data were available (from previous or subsequent

survey rounds) were compared to participating families for several household- and maternal-level characteristics. No differences in maternal education, maternal age, household size, animal ownership or agricultural production were observed between participating and non-participating families in either survey round. Community participation in intervention visits was similarly high with 82% of all families with children aged 0-36 months participating in at least one intervention visit. Almost no differences in maternal education, maternal age, household size, animal ownership or agricultural production were observed between households in treatment communities who chose to participate in intervention activities compared to those who did not participate. Those who did not participate seeded significantly more cereal grain crops (e.g. wheat, barley and rye) in the previous season compared to those who did participate, but no other differences were observed. Of the 117 mothers who attended any intervention activities and participated in at least one survey round, 83 were followed from baseline to endline. There were no differences found in the above characteristics between those who were followed and those who only participated in one survey round. The failure to find differences in several maternal- and household-level characteristics between self-selecting groups suggests that selection bias did not strongly influence study results.

Methodological considerations

Numerous authors have developed specific dietary diversity scores and indices (Hatløy et al, 2000; Ruel, 2003; Arimond and Ruel, 2004; Alvarado et al, 2005; Steyn et al, 2006; Daniels et al, 2009). Many of these indicators can be quite useful as simple tools for measuring micronutrient adequacy or other single aspects of child feeding. Likewise, the WHO IYCF indicators are

appropriate in certain contexts, particularly for describing population trends using data from large-scale surveys and national programs. However, smaller regional programs may not have sufficient sample sizes to make proper use of the WHO indicators and these indicators may lack the precision needed to evaluate such programs (WHO, 2008). Yet, community-based programs focused on child feeding still require simple, easy-to-use measures to evaluate changes resulting from their programs. Where programs are designed to impact multiple IYCF practices, evaluating these practices together, in addition to examining them individually, seems appropriate.

No differences were observed between treatment and control communities in the change in the WHO “minimum acceptable diet” summary indicator from baseline to endline, despite the large differences observed in the change in composite ICFI scores between treatment groups. The WHO “minimum acceptable diet” indicator and the ICFI, though both summary indicators, are quite different. For example, the WHO indicator 1) does not incorporate information on breastfeeding, bottlefeeding or food frequency consumption in the previous week, 2) for its “minimum dietary diversity” component, all children 6-23 months must meet the same standard of diet diversity to achieve the same score, 3) it does not include information on children older than 23 months, and 4) it produces a bivariate response (i.e. “acceptable” or “unacceptable” diet). Because the indicator only takes two values and requires six-month-old infants and two-year-old children to achieve the same level of dietary diversity to receive the same adequacy standing, it may fail to detect smaller, yet nutritionally significant differences in IYCF practices as compared to the ICFI (see **Chapter 3**). In both treatment and control

communities, the percentage of children achieving “minimum diet diversity” and “minimum acceptable diet” was greater at endline than at baseline. And there were no differences between treatment groups in the change in “minimum diet diversity” or “minimum meal frequency”. In contrast, the percentage of children achieving the high scores on the components of the ICFI (i.e. 24-hr diet diversity, 7-d food frequency, and 24-hr feeding frequency) increased from baseline to endline in treatment communities, but decreased in control communities (data not shown). The different trends reflected in these different indicators demonstrate the higher sensitivity of the ICFI in detecting differences in feeding practices. Its scoring system functions on a broader continuum, providing three to four age-specific scoring levels per component, thereby allowing for the detection of incremental changes in practices. For smaller, community-based programs interested in evaluating even moderate impacts on IYCF practices resulting from their programs, the use of an indicator that can detect more subtle changes in feeding practices is particularly beneficial. These programs may unfold over several years and see large impacts only after the program has had time to mature. Periodic and precise monitoring data to document incremental progress and respond accordingly are no less important for these smaller-scale programs. Especially for agriculture and rural development programs interested in incorporating nutrition goals into their work, precipitous changes in feeding behaviors or child growth resulting from long-term improvements in farm diversity and productivity, women’s time allocation, and environmental determinants of health and nutrition will likely be rare. And system changes resulting from agriculture programs are more likely to have impacts on multiple outcomes given that these programs have the potential to simultaneously improve several of the factors underlying child

malnutrition (Popkin et al, 1980; HKI, 1993; Bezner-Kerr et al, 2010). Therefore, an indicator such as the ICFI, that is sensitive to incremental improvements in several IYCF practices simultaneously, would likely be an appropriate tool, in addition to periodic child anthropometry, for evaluating progress in such programs.

The “minimum acceptable diet” indicator may also fail to represent more enduring child feeding practices to the same extent as the ICFI. The relatively large intra-subject variation in daily food intake lowers the precision of estimates of individuals’ usual food intakes based on single 24-hour diet recalls (Gibson, 2005). Therefore, a single dietary recall of the previous 24 hours may not reflect usual intake for any individual child and alone would not be an appropriate indicator to measure change in diet diversity. However, the 7-day food group frequency component of the ICFI adds an additional time vector to the index that accounts for feeding behaviors beyond the past 24 hours. Though the recall period for the 7-day food group frequency is greater as compared to 24-hour recall methods, food frequency questionnaires over longer recall periods have been shown to produce valid estimates of intakes of foods grouped into categories (Mullen et al, 1984). Particularly for infants and young children in resource-poor environments where smaller quantities and varieties of foods are consumed, 7-day food group frequency data may add to the ICFI’s ability to reflect more persistent IYCF practices and therefore, improve its performance as a measure of change in diet diversity.

No differences were observed between treatment groups in the 24-hour diet diversity component of the ICFI. Yet differences were observed when examining food group frequency

over the previous seven days. In an environment such as northern Potosí, where the diversity of child diets is often severely limited, assessing diets over a time frame longer than the previous day may be necessary to detect incremental shifts in the diversity of those diets. Given the high cost of collecting consecutive 24-hour food group recalls, especially in this region of Bolivia where communities are extremely isolated and difficult to access, and given the equally strong burden of surveys on families (who volunteer time, resources and personal information), collecting 7-day and 24-hour food group recall data together during one visit is an effective alternative to consecutive surveys. And these data are relatively easy to collect and incorporate into the construction of an index for the purpose of evaluation (Arimond and Ruel, 2002). Scores on an ICFI similar to that used in this study have been shown to remain stable over time in the absence of any intervention, suggesting that the index reflects more enduring phenomena (Moursi et al, 2008). Unlike the urban Malagasy population in the study by Moursi and others, ICFI scores in communities with no intervention in the current study demonstrated declining ICFI scores. As children in this region of northern Potosí aged, termination of breastfeeding was not compensated for by increases in feeding frequency and higher diet diversity as was observed in Madagascar. The strength of the ICFI in examining changes to multiple IYCF practices simultaneously can also present a challenge in that changes to individual practices can be masked (Ruel and Menon, 2002; Moursi et al, 2008). Therefore, it is important to examine individual practices, in addition to the composite ICFI score, to understand which practices are driving observed relationships and to be able to target those less-improved practices for additional intervention, for example.

Conclusion

An infant and child feeding index used to evaluate changes in IYCF practices resulting from an eight-month agriculture-centered nutrition education intervention detected significant differences between treatment and control communities in the change in ICFI score from baseline to endline. The intervention likely contributed to mothers maintaining adequate IYCF practices through the second and third years of their children's lives, but did not significantly improve the growth of children.

Caregivers face multiple barriers to improving IYCF practices and the growth of their young children in this region of Bolivia (e.g. poor access to health services, unsanitary home environments, numerous work responsibilities beyond child care, and limited access to diverse foods: see **Chapter 4** for more information); therefore, efforts to improve child growth should be carried out on multiple fronts. Fortification of the food supply, and provision of vitamin and food supplementation to children and women of childbearing age may benefit some communities in northern Potosí, but the extreme isolation of most of the communities in the region, like many rural regions in other parts of the world, makes the delivery of goods and services there difficult. Strategies like the intervention described in this study, that build local capacity through the use of local resources, are important starting points, however, other structural approaches are needed as well, such as diversifying farming systems, improving overall farm productivity, strengthening market linkages, revaluing the role of women to enhance their control of income and decisions regarding time use, improving transportation and irrigation infrastructure, and introducing improved agricultural technologies.

Practitioners interested in monitoring and evaluating the health and nutrition impact of agriculture and rural development programs that promote these types of strategies (and likely include a nutrition education component) may benefit from the use of a summary measure such as the ICFI. Food security and nutritional benefits do not necessarily immediately follow from agricultural investments, despite even efforts to target vulnerable groups such as young children (see **Chapter 1**). Therefore, it is important to track nutritional changes, not just in child growth (which may require greater time to observe improvements), but in upstream indicators such as the quality of child diets and the IYCF practices which determine those diets. Based on its 1) positive association with child growth and dietary adequacy (see **Chapter 3**), its ability to 2) reflect usual child feeding behaviors, 3) measure the adequacy of IYCF practices as a continuum and therefore detect small, yet biologically meaningful differences in IYCF practices , and 4) track changes in multiple feeding practices simultaneously in one summary indicator, an ICFI may be an appropriate evaluation tool, particularly for smaller, community-based programs interested in tracking overall progress toward improving feeding practices—even small, incremental progress.

Analyses using such indices should always include examination of changes to individual component IYCF practices in addition to changes in the composite index. Program evaluators should select indicators based on their specific goals and needs, their available resources, and the scope of their program. Further research employing ICFIs as evaluation tools should be conducted in a variety of settings to confirm the usefulness of the index in measuring incremental changes in IYCF practices. Further comparison of such composite indices with the

WHO “minimum acceptable diet” indicator should also be carried out, especially using smaller data sets where the differences between the two indicators are likely to be most pronounced, to further clarify for what purposes these two different summary indicators are ideally suited.

References

- Alvarado BE, Tabares RE, Delisle H, Zunzunegui M. Creencias maternas, prácticas de alimentación, y estado nutricional en niños Afro-Colombianos. *Archivos Latinoamericanos de Nutrición* 2005;55(1):55-63.
- Arimond M, Ruel MT. Progress in developing an infant and child feeding index: an example using the Ethiopia Demographic and Health Survey 2000. FCND discussion paper no. 143. Washington, DC: IFPRI, 2002.
- Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 Demographic and Health Surveys. *J Nutr* 2004;134:2579-2585.
- Asociación de Municipios del Cono Sur (AMDECO). Comunidades por Cantón y Sub Centrales: Elaboración Propia. Cochabamba, Bolivia: Asociación de Municipios del Cono Sur, 2009.
- Barnett AG, van der Pols JC, Dobson AJ. Regression to the mean: what it is and how to deal with it. *International Journal of Epidemiology* 2005;34: 215-220.
- Becquet R, Leroy V, Ekouevi DK, Viho I, Castetbon K, Fassinou P, Dabis F, Timite-Konan M, ANRS 1201/1202 Ditrane Plus Study Group. Complementary Feeding Adequacy in Relation to Nutritional Status Among Early Weaned Breastfed Children Who Are Born to HIV-Infected Mothers: ANRS 1201/1202 Ditrane Plus, Abidjan, Côte d'Ivoire. *Pediatrics* 2006;117(4):e701-e710.
- Berti PR, Jones AD, Cruz Y, Larrea S, Borja R, Sherwood S. Assessment and characterization of the diet of an isolated population in the Bolivian Andes. *American Journal of Human Biology* 2010;22:741-749.
- Bezner Kerr R, Berti PR, Shumba L. Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. *Public Health Nutrition* 2010; XX.
- Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide version 3. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.
- Comité Técnico del Consejo Nacional de Alimentación y Nutrición. Desnutrición Cero al 2010: compromiso multisectorial (Primera Aproximación). La Paz, Bolivia: Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006.

Cruz Y, Jones AD, Berti PR. Prácticas de Lactancia Materna, Alimentación Complementaria y Cuidados del Infante en el Norte de Potosí – Bolivia. *Archivos Latinoamericanos de Nutrición* 2010;60(1):7-14.

D’Agostino RB. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Statistics in Medicine* 1998;17:2265-2281.

Daniels MC, Adair LS, Popkin BM, Truong YK. Dietary diversity scores can be improved through the use of portion requirements: an analysis in young Filipino children. *European Journal of Clinical Nutrition* 2009;63:199-208.

Dewey KG. Guiding principles for complementary feeding of the breastfed child. Washington, DC, Pan American Health Organization/World Health Organization, 2003.

Dewey KG, Adu-Afarwuah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Maternal and Child Nutrition* 2008;4:24-85.

Dickin K, Griffiths M, Piwoz E. Designing by Dialogue: A Program Planners’ Guide to Consultative Research for Improving Young Child Feeding. Prepared for the Health and Human Resources Analysis (HHRAA) Project, 1997.

Frongillo EA, Nanama S. Development and Validation of an Experience-Based Measure of Household Food Insecurity within and across Seasons in Northern Burkina Faso. *J Nutr* 2006;136:1409S-1419S.

Garg A, Chadha R. Index for Measuring the Quality of Complementary Feeding Practices in Rural India. *J Health Popul Nutr* 2009;27(6):763-771.

Gibson RS. Principles of nutritional assessment. New York: Oxford University Press, 2005.

González W, Jiménez A, Madrigal G, Muñoz LM, Frongillo EA. Development and Validation of Measure of Household Food Insecurity in Urban Costa Rica Confirms Proposed Generic Questionnaire. *J Nutr* 2008;138:587-592.

Guldan GS, Fan HC, Ma X, Ni ZZ, Xiang X, Tang MZ. Culturally appropriate nutrition education improves infant feeding and growth in rural Sichuan, China. *Journal of Nutrition* 2000;130:1204–1211.

Guyon A, Quinn V, Rambeloson Z, Hainsworth M. Using the Essential Nutrition Actions approach to improve the nutritional practices of women and children at scale in Antananarivo and Fianarantsoa provinces of Madagascar: results and trends 2000–2005. Final Report, July 2006. LINKAGES, USAID.

Habicht JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. *International Journal of Epidemiology* 1999;28:10-18.

Hatløy A, Halland J, Diarra M, Oshaug A. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutr* 2000;3: 57–65.

Helen Keller International (HKI)/Asian Vegetable Research and Development Centre (Taiwan). Home Gardening in Bangladesh: Evaluation Report of the Home Gardening Pilot Project. New York: HKI, 1993.

Ho D, Imai K, King G, Stuart E. Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference. *Political Analysis* 2007a;15(3):199-236. <http://gking.harvard.edu/files/abs/matchp-abs.shtml>.

Ho D, Imai K, King G, Stuart E. Matchit: Nonparametric Preprocessing for Parametric Causal Inference. *Journal of Statistical Software*, 2007b. <http://gking.harvard.edu/matchit/>.

Instituto Nacional de Estadística. Ministerio de Hacienda. Gobierno de Bolivia. La Paz, Bolivia, 2004. [online]. Available at <http://static-200-105-141-238.accelerate.net/geoclip/launchmap.php>. Accessed 18 October 2010.

Kendall A, Olson CM, Frongillo EA, Kepple A. Validation of the Radimer/Cornell measures of hunger and food insecurity. *J Nutr* 1995;125:2793-801.

Kilaru A, Griffiths PL, Ganapathy S, Ghosh S. Community-based nutrition education for improving infant growth in rural Karnataka. *Indian Pediatrics* 2005;42:425–432.

Lai J, Yin S, Yang X, Ma G. Distribution of feeding index and association between feeding index and growth of infants and young children aged 6-24 months. *Journal of Hygiene Research* 2005;34:617-620.

Maluccio JA, Flores R. Impact evaluation of a conditional cash transfer program: the Nicaraguan *Red de protección social*. FCND discussion paper no. 184. Washington, DC: IFPRI, 2004.

Moursi MM, Martin-Prével, Eymard-Duvernay S, Capon G, Trèche S, Maire B, Delpeuch F. Assessment of child feeding practices using a summary index: stability over time and association with child growth in urban Madagascar. *Am J Clin Nutr* 2008;87:1472-9.

Moursi MM, Trèche S, Martin-Prével Y, Maire B, Delpeuch F. Association of a summary index of child feeding with diet quality and growth of 6-23 months children in urban Madagascar. *European Journal of Clinical Nutrition* 2009;63:718-724.

Mullen BJ, Krantzler NJ, Grivetti LE, Schutz HG, Meiselman HL. Validity of a food frequency questionnaire for the determination of individual food intake. *American Journal of Clinical Nutrition* 1984;39:136-142.

Ntab B, Simondon KB, Milet J, Cissé B, Sokhna C, Boulanger D, Simondon F. A Young Child Feeding Index Is Not Associated with Either Height-for-Age or Height Velocity in Rural Senegalese Children. *J Nutr* 2005;135:457-464.

Onyango A, Koski KG, Tucker KL. Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers. *Int J Epidemiol* 1998;27:484-489.

Pachón H, Reynoso MT. Improving Infant and Child Nutrition in El Alto, Bolivia: Results Using the *ProPAN* Methodology. (Lutter C, del Carmen Daroca M, León-Cava N, eds.). Washington, DC: Pan American Health Organization, 2002.

Popkin BM, Solon FS, Fernandez T, Latham MC. Benefit-cost analysis in the nutrition area: a project in the Philippines. *Social Science & Medicine* 1980;14C: 207-16.

Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. *Biometrika* 1983;70:41-55.

Ruel MT, Levin CE, Armar-Klemesu M, Maxwell D, Morris SS. Good Care Practices Can Mitigate the Negative Effects of Poverty and Low Maternal Schooling on Children's Nutritional Status: Evidence from Accra. *World Development* 1999;27:1993-2009.

Ruel MT, Menon P. Child feeding practices are associated with Child Nutritional Status in Latin America: Innovative Uses of the Demographic and Health Surveys. *J Nutr* 2002;132:1180-1187.

Ruel MT. Operationalizing dietary diversity: a review of measurement issues and research priorities. *J Nutr* 2003;133:3911S-3926S.

Sawadogo PS, Martin-Prével Y, Savy M, Kameli Y, Traissac P, Traoré AS, Delpéuch F. An Infant and Child Feeding Index Is Associated with the Nutritional Status of 6- to 23-Month-Old Children in Rural Burkina Faso. *J Nutr* 2006;136:656-663.

Srivastava N, Sandhu A. Index for Measuring Child Feeding Practices. *Indian Journal of Pediatrics* 2007;74:363-368.

Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition* 2006;9(5):644-650.

Todd P. Evaluating social programs with endogenous program placement and selection of the treated. In: *Handbook of development economics*. 4th vol. (Schultz TP, Strauss J, eds.), pp. 3847-94. New York: Elsevier, 2008.

UNICEF. *The State of the World's Children 2004*. The United Nations Children's Fund, 2003.
Vanek S. Soil gradients and legumes in mountain agroecosystems: N and P cycling and legume functional attributes in the Bolivian Andes. Doctoral dissertation. Cornell University, Ithaca, NY, 2010.

Wang Y, Chen C, He W. Study of establishing feeding index for children aged 6-23 months in rural China. *Journal of Hygiene Research* 2009;38:304-307.

World Health Organization. *Indicators for assessing infant and young child feeding practices. Part 1: Definitions*. Geneva, Switzerland: World Health Organization Press, 2008.

Zhang J, Shi L, Wang J, Wang Y. An infant and child feeding index is associated with child nutritional status in rural China. *Early Human Development* 2009;85:247-252.

6. Conclusions & recommendations

6.1 Key findings

The broad goal of this research was to determine the role that agriculture and rural livelihoods play in affecting the infant and young child feeding (IYCF) and care practices of women in the northern Potosí region of the Bolivian Andes. The specific research aims were to determine the nature of the relationship between IYCF practices and child nutritional status, the kinds of barriers mothers face to improving IYCF practices and, using an agriculture-centered nutrition education intervention as a catalyst for understanding how to overcome these barriers, determine if and how women were able to improve these practices.

Chapter 3 concluded that indeed, IYCF practices, as measured by an infant and child feeding index (ICFI), were positively associated with child growth, dietary energy intake, and the micronutrient density adequacy of child diets. However, the dietary diversity components of the ICFI were not associated with child growth. Rather, in the compositionally younger baseline sample of children, the feeding frequency component of the ICFI was most strongly associated with child growth, while in the older endline sample maintenance of breastfeeding was most strongly associated with child growth. These findings highlight the low diversity of child diets in this region of Bolivia, and that the differences in diversity between the most and least diverse diets may be nutritionally insignificant. Because the quality of complementary foods is so poor, frequent feeding of infants and young children, particularly with semi-solid and solid foods, is critically important, as is maintaining breastfeeding through to at least 24 months of age.

Nutrient-dense breastmilk makes a substantial contribution to the diets of these children. The

ICFI served as a useful summary measure of IYCF practices, but examining the relationships between individual ICFI components and research outcomes is also important so as to detect deficiencies in individual IYCF practices and to appropriately target intervention efforts.

In the following chapter, data from in-depth, semi-structured interviews with women during the course of the agriculture-centered nutrition education intervention revealed that women in northern Potosí face multiple barriers to improving IYCF practices, chief among them barriers related to the limited diversity of household agricultural production, the time women spend maintaining subsistence crops and herding animals, maternal self-efficacy, that is, women's perceptions of their capacity to learn and change, and the lack of support mothers receive from other family members including their spouses and mothers-in-law. Numerous other kinds of barriers were reported including family and individual preferences, perceptions and traditions that lead to poor quality diets, illness and poor health and sanitation environment that weakened nutritional gains from improved feeding practices, and the biophysical and ecological environment (e.g. climate, weather, plant pests and diseases, altitude, field slopes, land quality and soil erosion) among others. Those barriers specifically related to agriculture and the rural livelihoods of households in this region of Bolivia stood out as the most strongly associated with the ability of women to improve IYCF practices. Women's enormous work burden and time constraints were particularly salient issues, situated at a crossroads of influences, and underlying many of the child feeding barriers that women faced. Interview data with mothers indicated that women were able to achieve small gains in time-use efficiency to change feeding patterns and increase the frequency with which they fed their young ones. However, without

further support from time- and labor-saving technologies, improvements in agricultural and ecosystem management practices as well as families' capacity to cope with environmental risk, and most importantly, additional assistance from family and community members and shifts in perceptions regarding gender-specific labor activities, realizing substantial improvements to women's time available for child care will remain difficult.

The final chapter, Chapter 5, reports on the evaluation of the nutrition intervention. Mothers in treatment communities where intervention activities were conducted, on average, showed a significant increase in ICFI scores from baseline to endline (i.e. the one year period beginning in March 2009) compared to mothers in control communities whose scores declined during the same time period. The decline in scores observed in control communities was likely due to the difficulty mothers have in maintaining the standard of adequacy of child feeding practices as children age. As feeding frequency requirements increase and the diversity of diets must be maintained, the time- and resource-constrained women of northern Potosí are unable to adapt their feeding practices to achieve these standards. Women in treatment communities showed significant improvements in both the 7-day food group frequency component of the ICFI as well as the feeding frequency component compared to control mothers. The intervention may have succeeded, not in substantially improving women's IYCF practices, but in preventing the decline in these practices observed as children age. The ICFI has not been previously used as an evaluation tool to assess changes in IYCF practices. The index shows the dynamic nature of changes in these practices as children age and given the relative ease of the data collection efforts needed to construct the index and its ability to measure nutritional outcomes upstream

of changes in child growth, the ICFI may be a useful tool for incorporation into agricultural projects seeking appropriate indicators to evaluate nutrition impacts.

6.2 Policy and program recommendations

The daunting statistics on global levels of undernutrition and disease reveal the prodigious scope of the task facing policymakers and program managers who share a stake alongside other development practitioners, the private sector and communities in securing global access to adequate nutrition. The shifting landscape of nutritional priorities has at times, however, led to national decisionmakers receiving capricious, confusing guidance from which to formulate country policies (Bryce et al, 2008), and has contributed to a splintering of priorities among governments, donors, researchers, and civil society (Morris et al, 2008). A more coherent agenda of political and programmatic priorities is needed.

This research has emphasized the need for policies and programs aimed at improving young child nutrition to recognize the importance of women, their family environments and livelihoods. Women are the nutritional gatekeepers of households. Policies will succeed in improving nutrition to the extent that they improve women's capacity to educate themselves, control household resources, stay healthy and, in particular, thrive in their role as caregivers. The findings of this research demonstrate the strong association between IYCF practices and child nutritional status in northern Potosí, Bolivia as well as the difficulties women face in improving upon existing feeding practices and maintaining proper practices as their children

age. The capacity of women to properly care for their children in northern Potosí—women who depend on semi-subsistence agriculture for their household's food supply and livelihood—depends upon the quality and quantity of agricultural production, the support they receive from spouses and relatives, and the time they have available to care for their children outside of or during other work responsibilities. These multiple influences over feeding and care practices require that policies and programs aimed at improving these practices adopt a multi-pronged approach.

Educational and participatory community capacity building programs must serve as the cornerstone of efforts to shift cultural norms toward empowering women. And make no mistake, shifting cultural norms is ultimately what will be required to achieve long-term solutions to the structural issues underlying the nutritional problems highlighted in this dissertation. Women's time availability and workload, their education and health status, maternal capacity, intrafamilial power dynamics, and gender divisions of labor are factors that are all strongly influenced by cultural norms and were commonly cited by women as barriers to their ability to properly care for their young children. Participatory nutrition education and efforts to promote the importance of care for infants and young children, including formal education on caregiving administered through public primary and secondary school curricula, should serve as a starting point for building communities' capacity to overcome these barriers. Men, as much as mothers, grandmothers and mothers-in-law need to be involved in these efforts. Though women may bear the primary responsibility for child care in northern Potosí, they do not care for their children in isolation, but rather they do so in the context of families

and communities who influence women's practices through their action or non-action.

Therefore, it is important for such educational efforts to involve entire families and communities. Leveraging existing social capital (e.g. inter- and intra-community networks) to pool resources should be prioritized as a strategy for mobilizing families and communities to begin making changes and improving practices, even in resource-poor environments. Health staff and agricultural extension workers also have a central role to play in building awareness and catalyzing change efforts. In particular, gender diversity in extension and training efforts should be promoted to assure that child care is not relegated strictly to the domain of women.

Policies and programs are needed, therefore, to support the training of nutritionists in colleges and universities. Though food science and agronomy are common fields of study in Bolivia, nutrition is almost absent from post-secondary curricula. Many medical doctors, especially those younger physicians stationed in rural areas like northern Potosí, are ignorant on the topic of nutrition. Training in the importance of nutrition, its linkages to health and disease and best practices should be broadly implemented. This requires investment in education, especially investment in universities, colleges and training schools in rural areas where the problems of undernutrition are most conspicuous and where local students are intimately aware of the issues facing their local communities. In particular, cross-disciplinary training must be emphasized, both creating awareness among budding agricultural specialists of the importance of nutrition to their work and sensitizing medical students and other health professionals to the multiple underlying determinants of undernutrition and the structural, not only clinical, solutions required to confront these determinants.

Policies should also provide incentives to doctors, nurses, and other health staff to remain in rural health posts for long-term or even career appointments. Turnover of health staff, particularly highly-trained health staff, in northern Potosí is incredibly rapid. This leads to interruptions in service provision, dysfunctional systems operations, and a lack of coherence in programs. Policies that support investment in rural infrastructure (e.g. roads, public transportation, bridges, electrification projects), community development and the proper equipping of health facilities will likely encourage staff retention by ensuring that staff can travel safely and efficiently to and from their posts, rural communities have sufficient employment, educational opportunities and basic municipal services to support families and communities, and that health staff feel valued and are able to adequately carry out their work using proper equipment and receiving an adequate salary. These same investments in rural infrastructure, education and community development will also directly benefit farming communities and households.

Building upon educational campaigns to create awareness of the importance of maternal and child nutrition and efforts to strengthen community nutritional capacity and empower women, policies and programs in northern Potosí should focus on three long-term strategies that include short- and medium-term actions:

- 1) creating sustainable production systems that emphasize diversity and support proper nutrition (e.g. through homestead vegetable, fruit and small animal production, biofortified staple crops, soil conservation measures, improved crop management,

pasture restoration, integrated pest management, the use of zinc and iodine fertilizers, adoption of early and late-season seed varieties);

- 2) investing in and promoting essential nutrition actions (e.g. optimal breastfeeding practices and complementary feeding practices, nutritional care of sick and severely malnourished children, integrated control of anemia in pregnant women and children, promotion of iodized salt use, control of vitamin A deficiency, and improved nutrition for pregnant and lactating women) — these are direct nutrition actions delivered through health facilities and in communities (Helen Keller International, 2011; Diene, 2003);
- 3) ensuring equitable access to resources by women (e.g. improved market access and demand, particularly for women's crops, clearer property rights for women, equal access by women to a primary, secondary and post-secondary education, credit institutions, agricultural inputs, extension services, membership in users' groups or collectives, as well as investments in labor-saving technologies and the mechanisms for women to access such technologies (Kes and Swaminathan, 2006; Gill et al, 2010)).

All of these strategies require that nutrition be an explicit aim of policies and programs from the outset and that vulnerable groups are specifically considered and targeted in all efforts. Especially for the promotion of essential nutrition actions, but for the other strategies as well, Bolivia's multisectoral Zero Malnutrition Program offers a unique platform for coordinating and implementing nutrition-focused policies and programs. The program has already established

Integrated Nutrition Units in some local hospitals which serve as the operational arm of ZM's interventions (Hoey and Pelletier, 2011). The mandate of these units could be expanded to train health staff and agricultural extension workers on these essential nutrition actions and help them to incorporate nutritional messages and activities into their regular visits to communities. The political commitment and involvement of multiple sectors in this program (e.g. health, education, agriculture, water and sanitation, justice, micro-enterprise) should also be leveraged to take action across sectors to address the interdisciplinary determinants of the poor nutrition in northern Potosí.

6.3 Recommendations for future research

Experts have time and again issued calls for the need to strengthen the evidence base supporting the role of agriculture in improving nutrition. The research that is needed, however, is not research into *what* works, but research asking *how* agriculture influences nutrition outcomes in different settings for different families and what the relative strengths are of these different pathways. Basic biology and nutritional science tell us quite plainly that improving child care, diets and health status will yield nutritional and developmental benefits to children. We know food improves nutrition. We also know that food alone is not sufficient to achieve these gains. Further research is not needed to confirm the obvious, especially when the need to act to improve the situation on the ground is so dire.

The medical, nutrition and public health communities are accustomed to evaluating evidence from specific, targeted interventions (e.g. vitamin supplementation, facility-based management

of childhood severe acute malnutrition, use of insecticide-treated bed nets during pregnancy) whose impacts function along relatively short casual pathways. Pathways from agricultural investments to improved nutrition outcomes, however, do not operate in the same way. Even those investments with seemingly direct avenues of impact on nutrition (e.g. improved diversity of food production leading to improvements in diet quality) are mediated by multiple factors such as gender control of production and market decisions, household capacity to preserve foods, and behaviors and beliefs related to intra-household food allocation. Therefore, though study designs to evaluate the nutritional impact of agricultural investments certainly require strengthening, particularly with regard to establishing evidence to refute counterfactual arguments, randomized, (placebo-)controlled trials (RCTs) will likely never be a part of evaluations of such investments, nor should they be. Reviews and meta-analyses employing such trials as the standard of evidence will always find the evidence for the nutritional impact of agricultural investments wanting. Alternative evaluation designs, distinct from the RCT model, yet still rigorous, are wholly feasible for assessing the potential social, environmental as well as biological impacts of agricultural investments. These evaluations would benefit from interdisciplinary perspectives on evaluation, coordinated data collection employing diverse methodologies, and use of a set of indicators that assess short-, medium- and long-term nutritional impacts given that rapid changes in nutrition outcomes, particularly biological indicators, from agricultural investments are not always feasible.

Further research into appropriate indicators for use in evaluating the nutritional impact of agricultural projects is certainly warranted. The infant and child feeding index (ICFI) discussed at

length in this dissertation is one such indicator. The ICFI and the WHO IYCF indicators should continue to be applied and studied in a variety of settings, particularly in the context of smaller-scale programs where the differences between the indicators are likely to be most pronounced, to understand the relative strengths of these indicators in various settings. These indicators should also be vetted for their usefulness to agriculture and rural development projects as well as to assess the ease with which data may be collected to construct them. Detailed dietary data from quantitative 24-hour dietary recalls were collected as part of this research, however, program managers need not collect information at this level of detail to construct the ICFI. For some projects, even collecting data on food group consumption, feeding frequency and breastfeeding practices may be prohibitively complex or expensive. Therefore, it is important to develop additional indicators so that agriculture and rural development program designers have a menu of options to choose from and are not discouraged from including nutrition indicators in their program evaluation plans.

Project impact pathways (PIPs) should be examined to understand the cost-benefits of intervening along specific pathways and to assess the relative importance of pathways in different settings. The “management decision” nodes depicted in **Figure 1** are of particular relevance in illuminating the PIP black box. Disaggregation of data sets at the household level is critically important to gain insight into these management decisions, to understand the divisions of labor, responsibilities and decisions along gender lines within households and the reasons for nutritional impacts of projects (and just as importantly, lack of impacts) that are mediated by the agricultural management practices of farmers, the incomes and marketing

decisions of families, and the capacity of women to care for young children. Further research examining men's time use in particular, and their contributions to child care (either through direct care activities or indirectly by assisting women with food preparation, domestic chores and agricultural tasks to allow them to dedicate more time to child care) is especially needed to illuminate the motivations behind management decisions within households. A forthcoming collaborative study, based on survey data collected as part of this research, seeks to analyze the strength of the pathways between farm-side productive assets and environmental factors (e.g. cultivated land area, water resources, animal ownership, the net-primary productivity and slope of farmland, community elevation), farm management practices (e.g. manure and fertilizer application, fallowing decisions, production diversity, and risk management within communities and across elevations), agricultural yields, household food security and the diversity of household and child diets. This research will be an important first step to understanding these agriculture-nutrition linkages, but will necessarily fall short of teasing out gender differences in household management and production decisions because of a lack of available data. Collection of such data, though time- and resource-intensive to collect, should be prioritized in future research.

Ultimately, future research should pose questions that are directly applicable to vulnerable communities, households and individuals. Academic exercises to develop abstract theories of limited practical application to solving real-life problems should be eschewed, as should the development of technologies that are difficult for the poor to access. At a minimum, allocation of donor resources should be balanced between investment in technical fixes (e.g. food and

nutrient supplementation²⁹) and structural solutions. A combination of both strategies is certainly needed to fill gaps in short-term needs and to lay the groundwork for long-term change; at present, however, structural solutions are de-emphasized by the donor and research communities. This has to change if the underlying systems driving the decline in ecosystem services, and the persistence of poverty and poor nutrition around the globe are to be transformed.

²⁹ Lipid-based nutrient supplements (LNS) for example, initially conceived as ready-to-use therapeutic foods for management of severe acute malnutrition in emergency settings (e.g. Nutriset's Plumpy'nut), are now being promoted as supplements for chronically undernourished children despite the mixed evidence for their efficacy in this capacity (LNS Research Network, 2011). This phenomenon appears to be a 21st-century incarnation of the protein-rich mixtures of the 1960's such as "Incaparina" and "Pronutro" that eventually fell out of favor with the nutrition community (McLaren, 1974).

References

Bryce J, Coitinho D, Darnton-Hill I, Pelletier D, Pinstруп-Andersen P. Maternal and child undernutrition: effective action at national level. *Lancet* 2008;371:510–26.

Diene S. The Essential Nutrition Actions. Basics II Project, 2003

Gill K, Brooks K, McDougall J, Patel P, Kes A. Bridging the Gender Divide: How Technology Can Advance Women Economically. Washington, DC: International Center for Research on Women, 2010.

Helen Keller International. Essential Nutrition Actions. Website content. <http://www.hki.org/reducing-malnutrition/essential-nutrition-actions/>. [Accessed 13 May 2011].

Hoey L, Pelletier DL. Bolivia's multisectoral Zero Malnutrition Program: Insights on commitment, collaboration, and capacities. *Food and Nutrition Bulletin* 2011;32(2):S70-S81.

Kes A, Swaminathan H. Gender and Time Poverty in Sub-Saharan Africa. In: *Gender, Time Use, and Poverty in Sub-Saharan Africa* (Blackden CM, Wodon Q, eds.), pp. 13-38. World Bank Working Paper No. 73. Washington, DC: World Bank, 2006.

LNS Research Network meeting. University of California Washington Center. Washington DC, 8 April 2011.

Morris SS, Cogill B, Uauy R. Effective international action against undernutrition: why has it proven so difficult and what can be done to accelerate progress? *Lancet* 2008;371:608–21.

APPENDIX A

A CONCEPTUAL FRAMEWORK ON THE IMPACT PATHWAYS FROM SEMI-SUBSISTENCE AGRICULTURAL PRODUCTION TO CHILD NUTRITION

(ACCOMPANYING NOTES FOR FIGURE 1.1)

Numerous frameworks have been proposed showing the linkages from agricultural production and livelihoods to health and nutrition outcomes. This particular framework attempts to integrate the main themes of these past models into a more comprehensive model examining broad pathways and the particular components within those pathways. The framework pays special attention to *households* and the nutrition outcomes of *infants and young child nutrition* within those households. It was developed with an emphasis on rural, semi-subsistence, smallholder farming families and the dynamics that impact their livelihoods and well-being. Though some of the linkages represented can be generalized to urban-dwelling families (i.e. the influence of income and family purchasing decisions on child nutrition and their feedback to household labor supply), not all are applicable and the framework should not be overextended to such contexts.

Arrows represent proposed causal pathways between “exposure/outcome” boxes while flathead bars are “effect modifiers”. These factors modify the relationship between the two factors connected by the intersected arrow. These might be entered as interaction terms in analytic models. Labels in orange placed parallel to causal arrows explain the mechanism by which the proposed relationship functions. Labels marked with “ α ” and “ β ” simply call attention to components that are represented twice but on both sides of the framework’s main axis.

OVERARCHING INFLUENCES

There are a number of macro forces at play in modern society that profoundly influence families and production systems. Their effects on the pathways from agriculture to nutrition are not modeled directly in the conceptual framework as many of them are beyond the reach of influence of any single development project and because their effects are difficult to measure directly and to untangle from one another. But they are recognized here as interacting with nearly every component of the proposed framework and as critical influences that cannot be ignored when considering impact pathways.

Globalization has led to global market integration and the liberalization of previously protected domestic agricultural markets. As these markets have opened to foreign investment, transnational food companies (TFCs) have grown in size and influence and have intensified vertical integration and sourcing of products. By consolidating the process of producing, distributing and selling food, TFCs are able to gain more control over global markets and production decisions. Many farmers, especially smallholder farmers with fewer capital reserves and more susceptibility to short-term shocks, are less able to maintain control over the fate of their production or the prices they receive for agricultural goods. They are more dependent on the demands of fewer actors in a global system that requires increasing consistency in food quality and quantity. At the same time, globalization has been a boon for other farmers better positioned to take advantage of new technologies, improved communications, and the increasingly integrated global economy to increase their productivity, access new markets, and diversify their income. Individual governments' **policy environments** (i.e. pricing and trade

policies) and the international trade agreements drafted by transnational bodies such as the World Trade Organization have a great deal of sway in determining the relative benefit of the forces of globalization on semi-subsistence farmers in developing nations. For example, currency devaluations can encourage increased production toward export markets, and removal of export taxes and import tariffs on inputs, reduced restriction on foreign investment and changes in farm tax structures can drastically change farmers' investment patterns and behaviors. Government price supports for a certain commodity can make the difference between a successful commercialization effort and a disastrous one. In addition, national level policies to fortify staple foods can also have a direct, targeted benefit for families consuming those fortified products. The particular public **institutions** that are in place to govern, legislate, enforce, and implement policy as well as those civil society and private sector entities that are vehicles for implementing policies and stimulating economic growth and development help to shape the resource environment in which farmers operate independent of public policy. Government bureaucracy and corruption is a formidable barrier to many farmers accomplishing basic tasks such as securing a loan, acquiring proof of land tenure, or arranging a legal lot to sell goods at a formal market. Provision of public services such as transportation and communications infrastructure, water, sanitation and irrigation systems, and research and extension services that largely depend on public institutions for funding and implementation, may also be stalled when confronted with bureaucratic divisions, political infighting, lack of resources and expertise, and competing interests. Beneficial policies may be in place to support farmers, but if implementing institutions lack the resources, technical expertise, or management capacity to carry out those policies, no benefit will be realized.

Alongside globalization, and indeed in response to it, the **urbanization** of modern societies has resulted in shifting consumer demand away from staple foods and toward higher value crops and animal products. This change in demand has pressured food retail chains and restaurants to alter purchasing patterns and food quality standards from processors and producers.

Changing consumer behavior has thus limited market options for many smallholder farmers either because they cannot produce products of adequate quality or at the scale needed to stay viable. Even when able to meet the requirements of retailers and the processors they contract, the contract farming many producers enter into leave them bearing the brunt of the production risks associated with their contract. However, those farmers who have been able to adjust to the shifts in demand have found a reliable consumer base in urban residents, who now depend on someone else to supply their food. Initiatives linking small-scale, rural producers directly to local farmers' markets in urban centers have also opened up new opportunities for smallholder farmers in this rapidly urbanizing environment.

As city populations swell from rural-urban migration and from the forces of **population growth**, city boundaries encroach into previously rural areas. At the same time, more individuals vying for the use of the same amount of fixed resources has led to marginal lands being placed into production, overproduction and overgrazing on land already in use, and the rapid degradation and depletion of soils and water resources. **Climate change**, at least in part due to population pressure and the resulting anthropogenic greenhouse gas expulsion, is thought to be responsible for sporadic weather patterns (e.g. shortened, more intense rainy seasons), more frequent droughts and floods, shifting zones of cultivation, and the expanding reach of disease

vectors. Increasing population and a changing climate interact in complex ways to affect agricultural production potential and human health, and will undoubtedly continue to do so in new and unexpected ways in the future.

Finally, the influence of local **culture** and the support of **family** cannot be ignored when considering how agricultural production might impact nutrition outcomes. Historic cultural traditions and beliefs, especially in indigenous cultures, dictate how land is managed, how crops and animals are raised, and how children are reared and nourished. New knowledge and technologies that do not respect or integrate local customs and knowledge systems into their implementation strategies are likely to fail to take hold. Individual family members can heavily influence the decisions and practices of their relatives. While strong family structures are so critical to supporting change behavior and maintaining households (e.g., through psychological support and encouragement, contributions to the household labor supply, and through remittances to support family income), they can also hinder change that otherwise might benefit members of the family (e.g. a mother-in-law controlling food decisions and preventing the adoption of new feeding practices or a changed diet for her grandchild).

FRAMEWORK BACKBONE

As the focus of this conceptual framework is on the impact pathways from semi-subsistence agricultural production to child nutrition, the framework is constructed around a central spine that follows food from farm to fork and beyond, extending from a household's productive assets to a child's nutritional status within the household. Save for one exception, the

“exposure/outcome” relationships depicted for the five framework components included in the “backbone” are linear, that is, assets impact production which impacts food access which impacts individual consumption and finally child nutrition.

1) Household productive assets

These include the raw physical and natural resources with productive potential available to a family (ownership of, access to, quantity of, quality of): land (e.g. ownership of – land tenure; access to – distance from homestead; quantity of – hectares available for cultivation/grazing; quality of – soil quality and slope), vegetation (for forages, and wild plants for fuel, food, medicine), seed, water resources (including rainfall), sunlight, timber, and animals. These assets are clearly determined in large part by the biophysical and ecological environments wherein families reside.

2) Household agricultural production

This component includes the quality and quantity of products that a family is able to produce from the productive assets available to it: food, feed, fiber, fuel, materials for shelter and medicinal plants. The path extending from production to household productive assets represents the farmer’s decision to reinvest crop residues into the soil to replace harvested nutrients.

3) Household food access

Semi-subsistence farming families do not necessarily have access to all of the food that they produce, nor are they necessarily restricted access to other foods that they have not produced. These families engage in markets, whether they are informal or formal, local, regional or international, or cash- or trade-based. From the sale or trade of goods, families acquire other goods or income which they may then use to trade for or purchase other goods. Depending on the types of sales and purchases, the family's food basket can look quite different from what it would look like if the family were a strictly subsistence farming family. Post-harvest crop losses or the premature death of livestock can also alter the quantity and quality of food accessible to families. Landless laborers may rely on gathering wild foods and are represented here by an arrow between household productive assets and household food access. These individuals' food access is not mediated by agricultural production. Their access to food through trading labor for food or earning income on others' farms or in other wage labor is represented elsewhere in the framework.

4) Individual child consumption

Distinct from household consumption, this framework component represents the dietary intake of an individual child within the household.

5) Child nutrition outcomes

A child's nutritional status is most accurately represented by how well the child is growing, and so anthropometry (e.g. height/length, weight, mid-upper arm circumference) is most

commonly used to assess this status. However, measures of a child's micronutrient status (e.g. iron, zinc, vitamin A, iodine), or alternative development indicators (e.g. psycho-motor or cognitive development) may also be used to indicate how well a child is nourished.

MANAGEMENT DECISIONS

The conceptual framework highlights three critical points of management where actors within the system make decisions to alter specific outcomes given certain environmental factors and inputs. These points of management are perhaps most important to determining the direction and intensity of relationships, the trajectory of pathways, and the quality of outcomes within the framework. The “overarching influences” described above certainly influence these decisions, but they are also heavily dependent upon the following: 1) the individual's motivation for action (influenced by personal and family goals, societal pressures, traditions, beliefs and attitudes, and more intangible inherent motivation factors), 2) the knowledge, information, and skills available to the individual to make an appropriate decision, 3) the resources available to individual (e.g. financial, physical and natural capital), and 4) support and influence of others whether it be a spouse, family members, neighbors, or connections with outside authorities.

Management decision “A”

This point of management includes decisions about cropping systems, rotations, use of cover crop and fallows, what to grow, when and at what scale, decisions around tilling practices, soil conservation and erosion control, and pest management. These decisions directly affect the

quantity and quality of agricultural production yielded from the productive assets at a farmer's disposal and indirectly impact food production by: 1) altering the need to apply inputs, 2) changing the amount of labor required to turn productive assets into production and 3) modifying the effect of environmental factors on production.

Management decision "B"

Ultimately, a family has to decide what crops, animals, and/or materials will be sold and what will be retained for household consumption and use. Additionally, decisions must be made about how to spend household income, what proportion of it will be put toward food and what kinds and quantities of foods will be purchased.

On the path from household agricultural production to household income, this decision entails what products to sell for income, what proportion of the harvest to sell and when to sell it. On the path from household income to household food access, this decision entails what types of purchases to make with available income (both food and nonfood expenditures). A multitude of factors influence who makes market decisions within a household and the types of decisions made. The "overarching influences" described above briefly discuss the impact of national policies and institutions, international trade agreements, population, climate change, geographic trends, globalization and the influence of family and culture on farmers' market decisions. Many of these influences are macro-level, though their effects can certainly be felt at the level of individual households. The preferences of various family members, especially those with control over household resources, are strong determinants of market decisions. A

woman's status in family or society may limit her ability to make decisions regarding what to sell or how to use household income, particularly if the crop to be sold or kept is seen as a "man's" crop. Women tend to use household income in a manner that benefits the family and children. In families where women have greater control over income and market decisions, a greater portion of family income is dedicated to food purchases. Therefore, gender roles within families and societies are critically important to understanding the dynamics of household market decisions.

The quality of harvested agricultural products to be sold, the amount harvested and the ability of the farmer to store the harvest to sell at a later time (i.e. access to storage facilities) to take advantage of higher prices all influence market decisions. In addition, the relevant components explicitly represented in the framework (described below), all influence household income, and indirectly, a family's market decisions.

Management decision "C"

Decisions regarding child feeding and food allocation are usually made by the mother. As with the other management decisions above, these decisions are influenced by predictable factors, for example, a mother's knowledge about child feeding, her attitudes toward specific foods and practices, her beliefs and the influence and support of other family members, her education level, and her status within her family, community and society. Infants are entirely dependent on their mother (and other family members) to feed them during the first months of their life, and often into their second year. Therefore, child feeding decisions made by the mother are

critically important to the nutrition and development of a child. Decisions such as initiation of breastfeeding, feeding of colostrum, the duration of exclusive, partial and any breastfeeding, the frequency of breastfeeding, the timing of introduction of complementary foods, the quality, quantity and frequency of foods fed, the manner of feeding (e.g. responsive feeding), feeding during and after illness, and the distribution of food within a household will all help to determine the health, nutritional and developmental status of child as he or she grows.

FRAMEWORK COMPONENTS

Technology & inputs

Inputs include physical inputs such as fertilizers, pesticides, herbicides, and insecticides. Technology refers to irrigation infrastructure, tools and machinery, improved seeds, and processing facilities that are available to farmers. These technologies and inputs modify the relationship between household productive assets and agricultural production. They may also impact maternal health and nutrition (and the health of other family members) through risks from exposure to pesticides, other toxins and allergens, increased exposure to water-associated disease vectors carrying diseases such as malaria, dengue fever, or yellow fever (e.g. via the increased the availability of breeding sites for vectors from the use of irrigation). Beyond technology and inputs, maternal health can be affected indirectly by the productive agricultural assets available to the household if those include domesticated animals (e.g. through zoonoses and contamination of food and water supplies with feces, microbes, chemicals, toxic metals, etc.).

Labor supply

This component represents the allocation of labor within the household toward agricultural production: who does what work, how much time they dedicate to that work, and how productive they are while working. The amount of labor available to households, and the capacities of the individuals carrying out that work modify the relationship between household productive assets and agricultural production. “Maternal workload”, that is, the proportion of mothers’ time dedicated to activities other than agricultural production, impacts this component and in turn, the more agricultural production responsibilities that a mother bears, the less time she will be able to dedicate to other activities (e.g. child care, food preparation). Hence, the double-sided causal arrow between “maternal workload” and “labor supply”. This component also affects a mother’s health and nutrition via increases in energy expenditure and occupational health risks. The amount of labor available to families can also affect market access. If a family unit consists only of a mother and her children, it may be impossible to leave the farm to reach more distant markets (that require travel time to reach and social capital to access) that fetch higher prices for goods. Labor supply may also be dedicated to generating off-farm income; this linkage is particularly relevant for landless laborers whose labor is their sole productive asset used for earning income (through wages or trading labor in-kind) and accessing food.

Environmental factors

These include pests, disease, weather events and climate conditions. Environmental shocks and boons modify the relationship between a household’s productive assets and agricultural

production.

Household income

This includes income from any member of the household in the form of cash, in-kind payments, and goods for sale or trade. Income may be used, among other things, to purchase food, non-food items, hire labor, or invest in inputs and technology for the farm. This component includes the frequency with which income (particularly cash income) is available to the family, as this will in part determine what purchases will be made.

Value addition & storage

Value addition is a process of increasing the economic value or consumer appeal for an agricultural commodity. Though farmers may add value to goods for purposes of own consumption, here it refers to value addition exclusively with the intent to sell the good and generate income (“home processing” in this framework deals with processing foods for own consumption). Smallholder farmers may add value to certain goods individually (e.g. freeze drying potatoes at home before trading or selling them) or may partner with outside businesses to develop a marketable product (e.g. extracting oil from seeds, juicing fruits, milling grains to make flour, etc.). The scale of the value addition process and the extent to which smallholder farmers utilize middlemen to ultimately add value to their produced goods will in part determine the profit share that they capture from the process. Agricultural commodity value chains extend from production and primary food storage and processing to more downstream activities such as secondary food processing, distribution and retailing. Only primary and

secondary processing are captured here as they relate to the potential income received by a smallholder farmer from the sale of produced goods.

Farmer capacity to store crop harvests safely and securely can influence their ability to sell harvested commodities at variable times throughout year when prices may be more favorable and therefore increase their incomes. Poor storage facilities may lead to post-harvest losses of harvested crops, however, and may also lead to contamination of stored food crops.

Mycotoxins in particular, such as aflatoxin, can contaminate cereals and oilseeds before and after harvest and can affect the health of individuals consuming contaminated foods.

Off-farm income

This may include temporary or seasonal labor, regular, formal or informal employment, remittances from relatives in other countries or regions, or any source of income not related to the production and sale of agricultural goods produced by the family. This off-farm income directly impacts a household's total income.

Credit access

Bank loans and microcredit represent another source of income to families, an incredibly important source of capital especially for resource-poor families with little ability to cope with economic shocks. Loans directly contribute to a household's available income.

Food prices

Food prices clearly play an important role in farmer decisions regarding not only what goods to buy and sell and when, but also what crops and livestock to invest in for production. Perhaps more than any other component in the framework, food prices are vulnerable to rapid changes from influences far-removed from the local and regional contexts of households. National-level pricing and trade policies, international trade agreements, foreign direct investment, global surpluses and shortages, regional conflicts in other countries, investments in transport infrastructure (roads and ports) and processing and storage facilities can all impact food prices. The framework shows food prices modifying the relationship between household agricultural production and household income, and household income and household food access. This relationship might be equally well expressed as a direct arrow from food prices to the household management decision component regarding market decisions.

Nonfood prices

The price of nonfood items such as education, healthcare, transportation, and farms inputs certainly affect the amount of disposable income available to families. Especially among the rural poor who spend the majority of their monthly income on food, increases in the price of nonfood items result in fewer resources available to families to make food purchases.

Market access

Access to markets, whether they be intra-community or inter-community markets, regional or international markets, or formal or informal markets, determines the kinds of good families can

sell and purchase and the prices they will pay or be able to receive for those goods. Physical infrastructure, transportation costs, access to social capital to enter certain markets, and availability of sufficient household labor to spare a worker to travel to distant markets can all affect market access.

In addition, households with access to farming cooperatives, contract farming agreements with supermarkets, or value-added technologies may be able to reach more sophisticated and/or niche markets that support a unique consumer demand or that demand consistent delivery of a specified quantity and quality of goods that many smallholder farmers are not capable of delivering.

The framework shows market access modifying the relationship between household agricultural production and household income, and household income and household food access. As above with food prices, this relationship might be equally well expressed as a direct arrow from food prices to the household management decision component regarding market decisions.

Maternal health & nutrition

A mother's health and nutrition status has a direct influence on her children's health and nutrition. Children born with a low birthweight (<2500g) are at a higher risk of dying before their first birthday and have increased risk of poor health outcomes later in life. One cause of low birthweight is intrauterine growth retardation which is associated with a mother's low

prepregnant weight and inadequate weight gain during pregnancy, both of which are determined in part by maternal nutrition. Women who themselves were stunted as children are also more likely to give birth to low birthweight children, so that maternal nutritional deficits even before a child is conceived may play a role in a child's nutritional status. The quality (but not necessarily quantity) of a mother's breastmilk can also be influenced by her nutritional status. In addition, poor health status of a mother will impact her ability to spend time caring for and feeding her infants and young children, and her ability to perform any household work duty, thus impacting the household labor supply.

Maternal workload

Most mothers in rural, developing country settings are the keystone of households, bearing responsibility for food preparation, household chores, child care, and various agricultural production tasks from home gardening, to tending animals, to cultivating crops. These women are increasingly responsible for earning off-farm wages through temporary work migration to urban centers, selling goods at local and regional markets, or exchanging labor within and between communities. This high workload burden can impact the quantity and quality of time mothers have to feed their children, whether breastfeeding or complementary feeding. On the other hand, more time spent in child care and food preparation activities is less time available to dedicate to the labor supply that supports agricultural production activities. There is a key trade-off here between time dedicated to farm or family. For the mother however, the distinction may not be as clear as she may see her dedication to raising the household's crops and animals as directly improving the farm's agricultural output which in turn benefits the

family either through increased food supply or income. Therefore, caring for the farm is tantamount to caring for the family. A high maternal workload may also increase energy expenditure, limit a mother's time to devote to her own health, and lead to exposures to occupational health risks which can all impact a mother's health and nutrition.

Complementary feeding practices & food allocation behavior

Complementary feeding practices include the timing of introduction of complementary foods, the quality, quantity and frequency of foods fed, the manner of feeding (e.g. responsive feeding), the manner of preparation of complementary foods, and feeding during and after illness. Within this framework component is also included intrahousehold food allocation behavior which refers to differences within the household in the quality and quantity of foods fed to different individuals, particularly differences between adults and children, and siblings of different sexes. These practices modify the relationship between household food access and individual child consumption, that is, from what is available to the household, decisions around child feeding will determine what foods the child actually consumes. There is also a reciprocal relationship between complementary feeding practices and a child's health status. When a child is ill, he or she will often have less of an appetite and will not be able to absorb nutrients as easily if the gastrointestinal system is compromised. Therefore, it will be more difficult for a mother to feed her child in the "normal" manner. Likewise, a malnourished child (likely resulting in part from poor feeding practices) is more susceptible to the deleterious effects of infection and illness. The "vicious cycle" between child nutrition and illness is represented in part here.

Breastfeeding practices

Breastfeeding is a ubiquitous (and conspicuous) component of child feeding cultures in most nations outside the West. Breastmilk makes substantial contributions to a child's energy and nutrient intake in the first two years of life, and often into the third and fourth years of life as well. Breastfeeding practices include the initiation of breastfeeding, feeding of colostrum, the duration of exclusive, partial and any breastfeeding, the frequency of breastfeeding, and the manner of breastfeeding.

Home processing

Home processing includes modifications made to foods post-harvest, mostly practiced by individuals at home, but also carried out by community groups and cottage industries. Poor, smallholder farming families may also have access at times to larger commercialized processing operations, but because of the cost associated with this type of processing, it is not as commonly utilized. Home processing can be carried out to prepare foods for certain traditional recipes, to make foods more palatable or easily consumed, especially by younger children, to biochemically modify foods to make them safer for consumption, to increase the bioavailability of certain micronutrients, or to make perishable foods available for a longer period of time throughout the year. Some processing techniques include cleaning and soaking, milling and grinding, solar drying, germinating cereal and legumes seeds, preparing doughs through fermentation, and preparing gruels.

External food assistance

This component includes fortified complementary foods and products, home fortificants (e.g. micronutrient sachets), and other supplementary feeding items directed toward infants and young children supplied to families either through the government health system, NGOs, or the private sector. External food assistance can also include food aid (the causal arrow leading to “household food access”) distributed through various institutions to families whether in times of disaster or otherwise.

Child health status

Child health status, along with a child’s dietary intake, is an immediate cause of child malnutrition. The two factors, diet and health are bound together in a self-reinforcing cycle that may be vicious or virtuous. When child health is compromised, whether through diarrheal disease, respiratory tract infections, other infectious diseases, or through some other means, a child may be less willing to eat, will sleep more, and may not adequately absorb nutrients from foods. This will lead to undernourishment which will make the child more vulnerable to further or prolonged illness. Therefore, child health status is critical to a child’s growth and development. It affects a mother’s ability to properly breastfeed and feed complementary foods to her child, and directly impacts a child’s dietary intake.

Access to health services

Families living in isolated rural communities may have difficulty accessing health facilities that are located far from their homes. Many health systems have field staff that visit remote

communities to provide regular services (e.g. vaccination, growth monitoring, distribution of medicine, treatment for illnesses), but these visits are often not reliably carried out, and in some cases, this service is not offered. Transportation infrastructure, availability and affordability of public transportation, the health of the mother (and other family members) to be able to walk to or otherwise reach health facilities, and treatment of families by health staff will influence the level of access rural families have to health services. The quality of services provided is another part of this framework component. Many rural health posts have very limited resources with which to treat patients, and may need to refer patients to larger medical centers which may be prohibitively expensive or distant for some families to reach. Access to health services clearly influences maternal and child health.

Hygiene and sanitation environment

The same environmental hazards associated with agriculture that are shown to impact maternal health directly in the framework (i.e. fecal contamination in and around the homestead through animal rearing, and pesticide or chemical exposure) can also impact the general sanitation environment that children are exposed to, thus influencing their health. Hygiene practices, existence and use of latrines, hand soap and boiled water (which implies access to fuel to heat the water) are all factors influencing this framework component which in turn directly impacts maternal and child health.

Vitamin supplementation

Vitamin supplements (e.g. vitamin A supplements for children 6-59 months of age, iron drops

for children, iron and folic acid prenatal supplements for mothers), like external food assistance, are another outside source of nutrition, usually supplied by health system actors, that influences maternal and child health through dietary intake.

Nutrient bioavailability

Iron and vitamin A from animal food sources, for example, are more bioavailable to the body, that is, the body is more readily able to absorb and use these micronutrients when consumed from animal-source foods as compared to plant-source foods. Foods also contain numerous absorption inhibitors and facilitators that when combined in meals can help to make certain nutrients more or less available to the body. The composition of diets with regards to bioavailability of nutrients modifies the relationship between child consumption and the child's nutritional status (i.e. what proportion of the food consumed by the child is actually metabolized).

Mortality, morbidity, physical growth, disability, metabolic disease

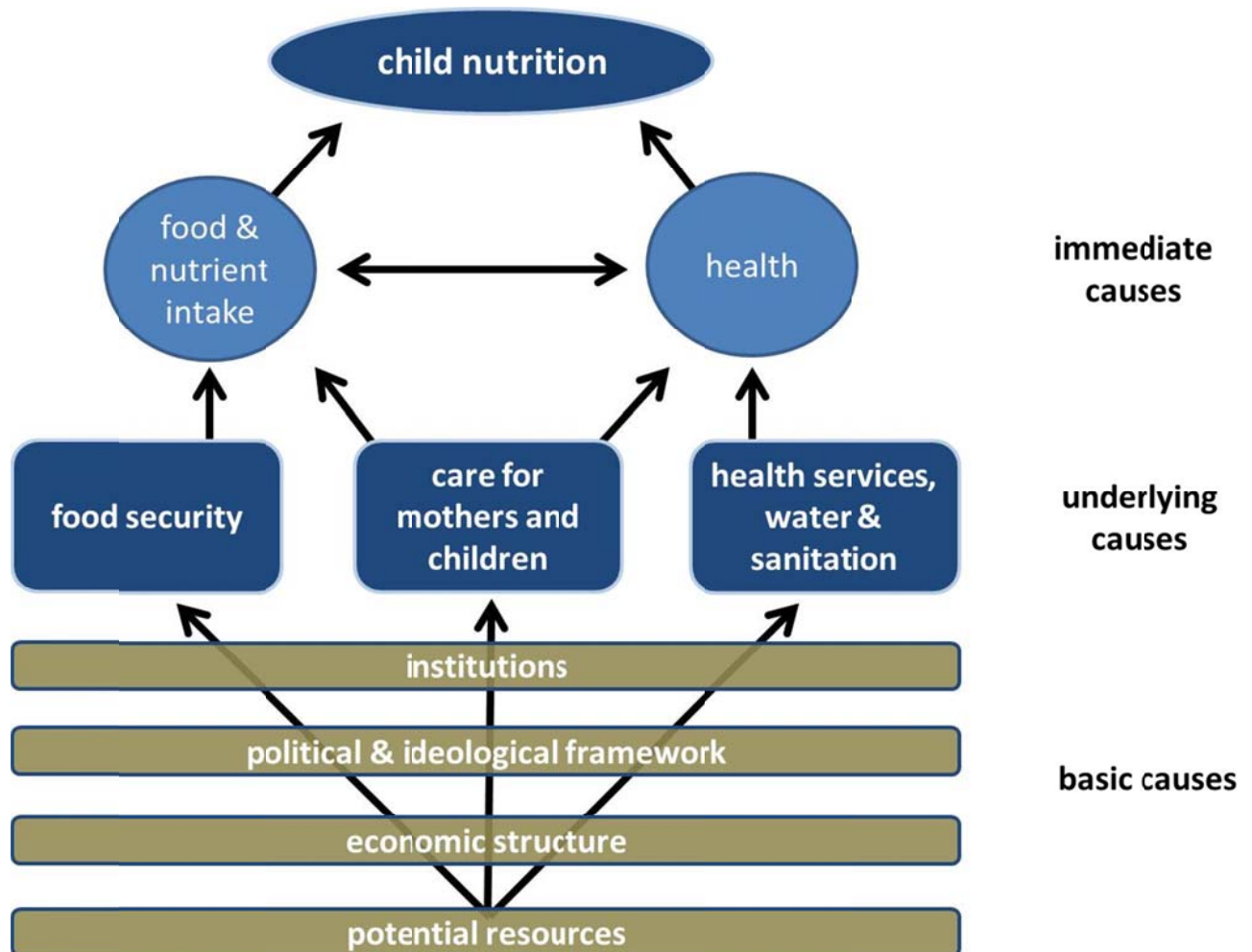
These framework components represent the specific outcomes which may be impacted by improper child nutrition. They lead in various ways to increased health costs for families (and societies), diminished future earning potential of individuals (which can lower a household's potential income if the children continue to contribute to the household income as they grow older), as well as reduced work capacity and labor productivity (which has consequences for the labor supply of the family farm).

Cognitive development & intellectual ability

Decreased cognitive development and intellectual ability resulting from malnutrition can lead to children not attending school, not finishing school, or performing poorly in school, which in turn may impact children's further educational opportunities, their future earning potential and therefore the household's potential income.

APPENDIX B

UNICEF CONCEPTUAL FRAMEWORK ON THE CAUSES OF CHILD MALNUTRITION



APPENDIX C

HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS) MEASUREMENT TOOL (ENGLISH VERSION)

NO	QUESTION	RESPONSE OPTIONS
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
4.	In the past four weeks, did you or	0 = No (skip to Q5)

	any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	1 = Yes
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes

7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)

APPENDIX D

TEN-QUESTION SURVEY MODULE ASSESSING MATERNAL KNOWLEDGE OF APPROPRIATE INFANT AND YOUNG CHILD FEEDING PRACTICES

The English form of the question as it was originally imagined is provided below along with the final Spanish translation that was arrived at following feedback from focus group discussions. Oral translations from Spanish to Quechua were then discussed and finalized for each question.

Question 1:

Until what age should you feed your child exclusively breastmilk before giving any other foods?

¿Hasta qué edad se debe dar solamente leche materna al niño pequeño antes de dar otros alimentos?

Question 2:

When a mother is feeding her child breastmilk frequently throughout the day, how does this influence the amount of her breastmilk?

Cuando una mamá da leche materna a su niño a cada rato durante el día, ¿cómo influye esto en la cantidad de su leche materna?

Question 3:

Until what age should you continue giving your child breastmilk frequently throughout the day?

¿Hasta qué edad se debe seguir dando leche materna al niño con frecuencia durante el día (meses)?

Question 4:

If your child does not want to eat, what do you normally do?

Si su niño no quisiera comer, ¿qué haría Ud.?

Question 5:

When your child is ill, for example with diarrhea, fever or cough, how should you feed the child?

Cuando su niño está enfermo, por ejemplo con diarrea, fiebre o tos, ¿cómo se le debe alimentar?

Question 6:

What should be the consistency of food given to a child who has recently begun receiving foods other than breastmilk (that is, a child who is about 7 months old)?

¿Cómo debe ser la consistencia de la comida para alimentar a un niño que recién empezó a comer (es decir, tiene 7 meses de edad)?

Question 7:

At what age should you begin to give your child solid foods, such as whole potatoes?

¿A qué edad se debe dar papawayku, o papas enteras a su niño (meses)?

Question 8:

How many times per day should you feed a one-year-old child solid or semi-solid foods so that the child is well fed?

¿Cuántas veces por día se debe alimentar un niño que tiene un año (no incluyendo leche materna) para alimentarse bien (veces)?

Question 9:

When your child is recovering from illness, such as diarrhea, how should you feed the child?

Cuándo su niño se está recuperando de la diarrea o de otra enfermedad, ¿cómo se le debe alimentar?

Question 10:

An 18-month-old child who eats in one day the kinds and quantity of foods you see in the photo is eating well. Do you agree with that statement? (The photo shows an amount of wheat and potatoes with the equivalent of 1.5 times the daily caloric value required for an 18-month-old

child receiving an “average” amount of breastmilk).

Un niño que tiene 18 meses que come lo que Ud. Ve en la foto durante el día recibe buena alimentación.

¿Cómo piensa Ud. En esta oración?